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RESEARCH AND PLANNING

THE planning of research in Great Britain and the efficient utilization of the scientific resources of the country have come increasingly to the forefront in recent months. The contribution of science to the war effort was the subject of comment by the Minister of Production in recent speeches, and Government provision for research was discussed in the House of Lords on July 15 and 20 (see NATURE, July 31, p. 129). On June 1, Sir Stafford Cripps made an important statement to the Parliamentary and Scientific Committee on "Future Requirements of Research and Technical Development in Great Britain and Supply of the Necessary Personnel", and that Committee has submitted a memorandum on scientific staffs to the Departmental Committee on the Training of Civil Servants. The Parliamentary and Scientific Committee has also prepared an important report on Coal Utilization Research and the National Economy, and a deputation from the Committee on this question was received by the Lord President of the Council on June 29. A research sub-committee of the Committee on Post-War Planning of the Institution of Electrical Engineers has issued a report on the organization of post-war electrical research, in which the formation of a British Electrical Research Board is proposed as an instrument to secure the maximum progress in the application of scientific research within the electrical industry in Great Britain.

Behind the details of any such concrete proposals there are broader issues which were touched upon, for example, in Sir Robert Watson-Watt's presidential address to the council of the Association of Scientific Workers in May, and in a letter from the chairman of the Joint Council of Professional Scientists and the presidents of the Royal Institute of Chemistry and of the Institute of Physics which has appeared in *The Times* and elsewhere. Sir Robert Watson-Watt pointed out that those who believe that a political scientist is a menace to science overlook the fundamental character of science. The fact that scientific workers are also citizens with responsibilities as members of the State which transcend their individual needs and interests means that they are bound to attempt to exert some influence on the public policy of the State. As scientific workers they are concerned with the accumulation and acceptance of ordered knowledge, but as citizens they are profoundly concerned with the application of this accepted knowledge for the general good of the State and of the world at large.

That position is not inconsistent with the warning which is sounded in the letter from the Joint Council of Professional Scientists mentioned above, and repeated in a subsequent interview by Sir Robert Pickard, against exaggerated expectations of rapid results. The time-lag in the application of research is one reason why it is important that immediate preparation should be made for reconstruction, and the necessity for planning a long way ahead is one of the reasons why planning is as important for the advance of science as of society. There is, in fact, as Sir Robert Watson-Watt remarked, no alternative

to planning but the dream-world which he labelled "planned sporadicism".

The real question is the character, the objectives and the limits of planning. It should be a means to an end and not an end in itself; and the purpose or end which planning is to serve is the all-important criterion as to whether planning is good or bad. On this we may well note the denial in the letter from the Joint Council of Professional Scientists of the contention that the man of science is pre-eminently fitted for the position of leader in a democratic community. The weakness of that position, which is rarely claimed by responsible men of science, has been shown admirably by Prof. E. H. Barker. The man of science might well be consulted more frequently than he has been in the past, and we may well develop a more effective technique for utilizing his advice and services. When that advice has been given, however, the duty of the man of science, as such, is at an end; his claims to be considered an administrator or statesman must depend on his possession of knowledge and ability covering wider fields. The argument that scientific knowledge and ability are not inconsistent with the possession of administrative ability, and that they should not be allowed to debar the scientific worker as such from high administrative positions, must not be construed into an argument for the placing of scientific men or women in administrative positions on the ground of their scientific qualifications. That might, indeed, be a short cut to a soulless technocracy indistinguishable from despotism.

Fortunately, there is no reason to rate that danger as high. The emphasis laid in recent pronouncements on the education of scientific workers on the importance of a sound general education as a basis for specialization, like the emphasis now being laid on the necessity for any administrator to possess a broad appreciation of the nature of scientific method, the achievements and potentialities of research and of the structure and methods of scientific industry, is some assurance that mistakes of the past are on their way to being rectified. Effective planning, in science as elsewhere, presupposes a high standard of education in the broad as well as in the technical sense. No plans for post-war reconstruction are, in fact, more important than those which relate to education, whether of the administrator or of those whom he is to serve, and the success or failure of our efforts to build a better world and to achieve the four freedoms, like the security of our democratic institutions, ultimately depend on our ability to meet the searching demands which they make on us in character and in intelligence.

Remembering, therefore, that planning in science, as in a democracy, must be planning for freedom, and limited to those measures which will further the broad objectives desired by the community, we can proceed to consider the measures which may be required in particular fields. It is natural that our closer association with the U.S.S.R. should stimulate interest in Soviet achievements, which Mr. J. G. Crowther recently dealt with in the Trueman Wood lecture before the Royal Society of Arts, and on which Sir Stafford Cripps touched in his statement before the Parliamentary and Scientific Committee. Those achievements are often compared with the research effort of Great Britain, much to the disadvantage of the latter, and it may well be that Sir Stafford Cripps is right in holding that we have even yet not realized to the full the place that research should take in development and production.

Admitting that the pre-war provision for research in Great Britain compares unfavourably with that of the United States or of Soviet Russia, it must not be supposed that the position can be rectified immediately by the allocation of financial and material resources more commensurate with the effort required. The supply of personnel alone, as Sir Stafford Cripps observed, is an obstacle to rapid expansion, and the difficulties in obtaining a sufficient number of research workers at present experienced by the various Supply Ministries are likely to be encountered in industry and elsewhere after the War. A shortage of this kind can only be eliminated as a result of an appropriate educational policy. The research worker, moreover, is only one member of the team of scientific workers and technicians required; the skilled technical personnel for the technical applications of scientific research and for the engineering and development work involved must also be available.

To increase the relatively small output of suitable men and women from the universities and higher technical colleges is a matter of educational policy, and this is ultimately the responsibility of the State, which now provides directly or indirectly a very large measure of the finance and planning of educational facilities. As yet it has not been decided how we are to plan and manage the whole range of basic and applied research necessary to safeguard the future of our industries. What is required, Sir Stafford said, is to increase the volume of research, both basic and applied, and, at the same time, to introduce some measure of planning so as to make the best use of the available resources. We must also decide through what agencies we want this research to be carried out, and how much of our national wealth we are prepared to devote to the research itself, as well as to the provision of the personnel for research, technical development and production engineering.

Sir Stafford Cripps is clearly of the opinion that the need cannot be met entirely by private research institutions—they have not the resources available in national institutions—but he did not commit himself so far as the report of the Committee of the Institution of Electrical Engineers in condemning the competitive basis of industry as opposed to the re-organization of research on co-operative lines. The proposals for a British Electrical Research Board may be held to depend too much on a basic change in the character or structure of industry, the value of which is at least open to debate.

Sir Stafford Cripps himself looks rather to the establishment of further State institutions—he instanced the need for a first-class institution for aeronautical research—as the feature of a State research service. He also considers that we need

a State scientific service, apart from, but on a parallel with, the administrative Civil Service. Such a service should be under the control of a single responsible Minister able to draw together all the threads of scientific effort so far as the State is concerned. The actual administration of the research should be under the control of a body of men of science: he suggested that the Royal Society, if provided with a special administrative staff for the purpose, might perform that function.

While he emphasized that these matters are primarily for scientific workers to determine, even if their decisions must take the form of advice, Sir Stafford regards such developments as a natural growth out of the present haphazard system. He suggested the introduction of a consolidating and enabling Bill to deal with the whole question, and to correlate it with the work of the universities and the industrial research institutions. He believes we must envisage spending after the War at least ten times as much as in 1938–39 if we are to make headway or even to keep abreast in such industries as the light chemical, optics, radio, civil aviation, as well as in the heavier industries.

In replying to a question from Prof. A. V. Hill regarding the means of raising the status of the scientific worker, the importance of which Sir Stafford Cripps had stressed, Sir Stafford suggested that this would be one consequence of establishing a Government scientific service and that the process would be further assisted by the expansion of our research effort. Prof. Hill also raised the question of the possibility of a superannuation scheme not only in universities and in some Government establishments, but also throughout the scientific services and industry. Sir Stafford Cripps agreed that some correlation in this field would be possible, but valuable as such a scheme would be as a stimulus to the interchange of personnel, it involves certain dangers to the individual initiative and independence of the scientific worker. The dangers of State control are elaborated by Prof. M. Polanyi in a recent paper on "The Autonomy of Science" (*Mem. Proc. Manchester Lit. and Phil. Soc.*, 85, 19–38). Prof. Polanyi's admirable argument for the importance of the autonomy of science, however, will be as warmly welcomed by those who are urging the more rational use of our scientific resources as by those who attempt to argue that planning and science are incompatible.

Prof. Polanyi himself appears to confuse the broad planning and orientation of scientific effort to secure a steady advance along the whole front and the apportionment of scientific effort where fresh knowledge appears to be most required, with the interference with scientific results and the suppression and distortion of truth which we have witnessed in the totalitarian States. Scientific men can never give a guarantee of results. They cannot fit their discoveries to suit preconceived ideas or desires without disloyalty to the quest for truth which is of the essence of their calling. A research worker who deliberately concealed some fact in the field of vaccines, for example, because it was inconvenient or inconsistent with a Government policy of vaccination, is indeed disloyal to science and could no longer claim to be a scientific worker. He would not, however, be impairing that loyalty and his professional integrity if, as Prof. Polanyi appears to argue, in response to a request from the leaders of his profession, he laid aside for the time those investigations to undertake work in some other field, for which he was equally qualified, where a solution to some other problem was urgently required for the relief of suffering.

It is no argument against the planning of science that we cannot tell where the fundamental discoveries or the real advances will be made. That view has indeed been strongly challenged by Bavink, who argues that in the physical sciences it is possible to state within limits exactly where lie the problems still to be solved, though he does not claim that the applications of such fundamental discoveries are equally predictable. What is axiomatic is that we cannot escape the responsibility for prosecuting scientific effort, where according to our best judgment it is likely to be most fruitful. That judgment may prove to be mistaken, but if it is honestly made, based on a critical survey of the facts of the whole situation so far as they can be determined, we are at least not open to the charge of prostituting science or wasting scientific resources. We have made an attempt at something more than a guess at the direction of further progress, and the mistake itself can prove a stepping-stone for a further advance.

Scientific workers should not therefore be reproached for disloyalty to science when they accept a broad direction as to the fields in which they should work. Planning to that extent does not encroach on the essential freedom of the scientific worker, his creative powers and initiative, his professional integrity. Prof. Polanyi has described this position of the scientific worker and the indispensable autonomy of his creative life so admirably that it is, to say the least, unfortunate that he should impute to the type of planning and organization of scientific effort and resources urged by Sir Stafford Cripps an attempt to interfere with the internal discipline of science and the decisions leading to discovery. Sir Stafford Cripps, like every other serious advocate of the more effective organization of our scientific resources, makes it clear that while the community may, and should, claim the right to determine within broad limits the extent of the resources to be devoted to scientific and technical research, and the broad allocation of those resources between different fields and on major projects, that allocation must be subject to the advice of men of science themselves, and the technique and the manner in which the particular problems are attacked must be the affair of the scientific worker alone.

Planning for freedom in this manner accordingly involves a more efficient organization of the scientific community itself, the elaboration not merely of the machinery for exercising more effectively scientific discipline, particularly in those borderlands of the sciences where advance has so often been most fruitful, but also of the machinery for assisting the allocation of effort between the different fields and determining the major programmes of work. More-

over, there must be the proper organization of the scientific community in its relations with the society and nation of which it forms a part, so that scientific advice can be more effectively brought to bear on the problems of the nation and supplied in terms understood by administrators and the people at large. These considerations are all involved in the effective planning of science for freedom. The education of the man of science himself is only a part of the large task of education to be undertaken, and in addressing themselves to those problems of the more effective organization of our scientific resources on which Sir Stafford Cripps touched and the rapid expansion of our endowment of research, scientific workers must not overlook these important questions of the re-organization of their own community, so that their knowledge may be presented to the community and its leaders in the most effective channels and in the most lucid and widely understood manner.

SOURCES AND IDENTIFICATION OF TIMBERS

Timbers of the New World

By Samuel J. Record and Robert W. Hess. Pp. xv+640+58 plates+8 maps. (New Haven: Yale University Press, 1943.) 10.00 dollars.

THIS monumental work is packed with most valuable and up-to-date information. In Prof. Record's well-known scientific and methodical manner no stone has been left unturned, and no effort spared, to treat the vast subject with accuracy. Probably in no part of the world could one find authors so well equipped, at least as regards the timber, to handle this great task, for apart from their own wide knowledge, they have access to the unique collection of 40,600 wood samples at Yale University, which is probably the largest collection of wood specimens in the world. Moreover, for the past eighteen years Record has published a journal known as *Tropical Woods*, which has included information on this subject gathered from all quarters of the globe. In addition, the long list of well-known names under the heading of "Bibliography" displays an exhaustive range of research.

The book is the more welcome since it arrives at a moment when we are unexpectedly faced with an alarming depletion of our own reserves of forest, and many sources of supply have been cut off, some perhaps permanently, and others at least for a long period. Although "The New World", as the authors term it, has already provided a large and regular supply of timber for many years, it may very well be that it still contains a great remaining store—at least of hardwoods—in a world the history of which reveals one continual source of forest destruction—by war, by fire, and by the march of civilization—which in all ages has destroyed without replenishing a most necessary element for its prosperity.

The book contains detailed descriptions of each tree, its geographical situation, its timber and comparative durability, the purpose for which it can be used, and last but not least the multiplicity of names by which it is known in all the different countries. This multiplicity and duplication of names, in the Brazilian timbers alone, has caused complete confusion, one which might justly be compared with the difficulty which confronts the chameleon when placed upon a Scottish tartan. Many of the common names are repeated for woods which are of entirely different qualities, and indeed of different colour, but all named alike. Record's work will help to correct these difficulties.

Mr. J. S. Gamble's brother—Colonel Gamble, who spent a great number of years in Brazil—got together an exhaustive and well-chosen selection of the timbers of that country, which collection came into my possession more than twenty years ago, and afforded a very useful basis for checking up those specimens which I already had, and introducing new kinds not formerly available. The whole collection was named according to the local names of the district from which the specimens had been taken, and on this account the greatest difficulty in identification was experienced.

When it is realized that 1,100 genera are included in the book under notice, a faint impression of the Herculean effort can be obtained.

Those who are interested in the timbers from South America will have their task made easier, although they will still meet with some unexpected changes of names.

It is not often that a first-class botanist has the opportunity of also becoming an experienced timber expert. In this case, however, Record is a past-master as botanist, forester, and in the intricate study of wood structure.

The association of the botanical relationship of trees and the wood which they produce is, of course, extremely close, and the dual study is of the greatest interest, but whether in a treatise on *timber*, or the *trees* which produce the timber, the subject should be carried into the realm of families of trees, might be open to question. From the commercial, or craftsman's point of view, the family of the tree which has produced the wood is of no importance; for example, beech belongs to the family Quercineæ, which includes also the oaks and chestnuts, and Castanopsis, the woods of which are entirely different. Again, to couple the botanical name with the common name of the wood only adds confusion.

Of late in Great Britain the required conditions of some contracts have had added to the common name of the timber the botanical name, as for example English ash, *Fraxinus excelsior*, whereas the term "English" ash is fully sufficient. Many honest operators will not sign the conditions of such contracts, as they contend that they do not know the botanical side, but the qualification 'English' alone would be sufficient to ensure a correct delivery. In a demand for teak the additional name is superfluous, the name Burma or Indian teak being sufficient, as there is only one species available. Again the botanical term is unnecessary, but when we come to supplies of mahogany the case is different. The authors state "*Swietenia* [is] the source of the only and true mahogany", which pronouncement may be correct, but also may not. A very controversial subject is opened if it is proposed in any individual endeavour to confine the supplies of mahogany to Swietenia sp. For more than three hundred years mahogany-like woods have been passed as mahogany, and the resulting confusion, while it has had little notice throughout the United Kingdom, has caused much dispute and litigation in the United States. The subject is one on which a great deal might be said, but it is sufficient for the present review to direct attention only to the difficulties which are

encountered if botanical terms and families of trees are to become an integral question in relation to timber.

These remarks, in any event, although suggested by the book, do not in any sense affect its usefulness, as the method adopted enables the reader to make easy reference. The whole work is supplemented by an excellent index, covering no fewer than fifty-two pages—by itself a remarkable achievement, which must have required great diligence and patience.

There are thirty-six well-chosen illustrations, of unusual interest, and twenty-two pages of photomicrographs, as well as exhaustive "Lists of families classified with reference to special properties and uses of their bark, leaves and timber".

In addition, the book contains illustrated maps, whereon are noted the areas whence the various woods are obtainable, with particular reference to those to which individual species are limited; information, both for the present and the future, of inestimable value.

This book, without which no arboricultural library would be complete, embraces all the interests of forestry and timber, and provides a fund of information never before available, surpassing those valuable contributions on this subject which we already possessed, and even the work which Prof. Record himself and his associates have formerly completed.

ALEXANDER L. HOWARD.

PLACE-NAMES OF CAMBRIDGESHIRE

The Place-Names of Cambridgeshire and the Isle of Ely

By P. H. Reaney. (English Place-Name Society, Vol. 19.) Pp. lxi+396. (Cambridge: At the University Press, 1943.) 23*s*. 6*d*. net.

A LOT of water has flowed even under the bridges of the Cam since Prof. Skeat published his monumental work on the place-names of Cambridgeshire, and much new information, archæological and otherwise, has accumulated since that date. It has been shown that the area was peopled by Anglo-Saxon folk from a very early date—before the end of the fifth century—and the researches of such investigators as Sir Cyril Fox, T. C. Lethbridge and others have thrown a flood of light on these early migrants, their origins, movements and modes of life. The place-names of the county, in spite of the absence of *ingo's* endings, confirm the existence of these early settlements. The occurrence of personal names, ancient and rare words and primitive forms of compound make this clear. Celtic influence, on the contrary, seems to have been slight, so far as the place-names are concerned, though the river-name *Granta* and some other stream names do appear in some compounds. Scandinavian influence, though not strong, is noticeable, though only two villages—Toft and Bourn—are of pure Scandinavian origin. Again, Anglo-Norman influence was also apparently not strong.

The author will scarcely expect his work to be used as armchair reading; yet the fact is that anyone who knows the county finds himself looking up the name of village after village for the interest of what he will learn. It is dreadful to find by how narrow a margin Grantchester—which should be spelt Granteseta, meaning the settlers on the Granta—escaped being Grandchester, a horrid hybrid meaning the big Roman camp! Westley Waterless actually means water clearings to the west (of Dullingham); waterless being a corruption of waterlees or water meadows.

After an all too short introduction and some necessary fore pages, an account is given of the river-names, followed by those of the famous dykes. There then comes an account of Cambridge and its immediate environs, including the origin of the names of many of the streets. The rest of the book is devoted to the villages of the county arranged by hundreds, brief mention being given in each case of some names in the parish of fields, woods, houses, etc., which are of interest from an etymological point of view. These references, in the nature of the case, cannot be complete; space would not permit, and many people with local knowledge will necessarily look in vain for the origin of some familiar but not understood field-name. An index and three maps in a folder complete the volume.

This is certainly a work to possess, and the author is to be congratulated on its production. A small point struck me as interesting. How many inhabitants of the south-west part of the county remember that the villages of Great and Little Chishall and Heydon were transferred to Cambridgeshire from Essex so late as 1895? I can only testify that to-day the emotions of Heydon are strongly Cambridgeshirewards, with indeed some slight antipathy to Elmdon, the nearest place in their former county of Essex!

M. C. BURKITT.

X-RAYS IN INDUSTRY

X-Rays in Research and Industry

By Dr. H. Hirst. Pp. 96. (Melbourne: Tait Publishing Co. Pty., Ltd., 1942.) Cloth, 7*s*. 6*d*.; paper, 5*s*.

IT seems to be the fate of the physicist to provide the tools for others to finish off the job. X-ray physics has provided a very practical tool for studying the inner structure of materials. Inevitably it has become the concern of the chemist, metallurgist and engineer. This, however, is a good omen, and for further effective application of X-ray work one looks forward to increasing contributions from people interested in the structure of materials from points of view other than that of the pure physicist. This book by Dr. Hirst, who surveys the field for the metallurgist, is a welcome sign.

Dr. Hirst considers both X-ray diffraction and X-ray radiography, and sets himself two tasks: to point out the type of application in which the X-rays might profitably be employed; and to give such guidance in technique that the metallurgist might hope to tackle the X-ray work himself. He has achieved both aims admirably, and made a useful contribution to a literature which has not catered greatly for the practical worker. His presentation is brief, but to the point.

In X-ray diffraction, the author has chosen the applications to study of alloy systems and stages in precipitation, chemical testing, temperature effects, grain size, and the structural changes accompanying plastic deformation. These applications are well known and have been described before, but scarcely with such emphasis on practical procedures. This makes the book useful to the newcomer, who is given tangible directions to go on, and interesting to the older hand who can compare notes and occasionally criticize. One criticism which might be allowed is

that the working metallurgist will not wish to be limited to a circular camera technique which involves the reduction of his specimens to the form of filings or powders. He would soon require an arrangement to take normal whole specimens, preferably permitting of metallographic as well as X-ray examination. One also misses reference to the X-ray methods for measuring internal strains, which are finding extensive application, for example, in the examination of welds and problems of stress relief. In his treatment of radiography, Dr. Hirst has again emphasized the practical side. Industrial radiography has grown rapidly since the War began, and now consumes photographic film at a rate which would surprise the cinema industry. The standard is not uniformly high, and the practical points made by the author are not out of place. A clean radiograph, especially of an awkwardly shaped component in heavy metal, is often simpler in theory than in practice, and in this connexion, perhaps more reference would have been made to the use of filters in the primary beam, and to devices other than the use of lead paste to ensure the vital screening from unwanted radiation.

Whether the treatment of the principles and practice of X-ray diffraction is sufficiently comprehensive, as Dr. Hirst suggests, will depend on the work with which the practitioner is likely to be most concerned. In many fields it will certainly suffice for anyone to make a confident beginning, in which he will be aided by the initiative of certain manufacturers in putting reliable X-ray equipment on the market. Experience has shown that various types of work can be reduced almost to routine and undertaken by personnel without highly specialized training. On the other hand, there will always be investigations calling for considerable experience and versatility in interpreting and adapting the X-ray work. There will also be firms who may wish to use the method occasionally but not so often as to justify the expenditure on equipment and staff. Then there is a real case for the work to be undertaken by a central organization. To some extent this has been met in Great Britain by the facilities provided by the Department of Scientific and Industrial Research and by university laboratories. But the problem would repay systematic study, for the issues involved are not peculiar to X-ray work, and are likely to be encountered more frequently with the increasing complexity of scientific development and the growth of specialized techniques.

W. A. WOOD.

MAP PROJECTION

An Introduction to the Study of Map Projection By Dr. James Mainwaring. Pp. viii+114. (London: Macmillan and Co., Ltd., 1942.) 5*s*.

IT is a common complaint that examination syllabuses exert an undue influence on the school curriculum; but it is a chastening reflexion that, in the case of map projections, the regulations of examinations boards have, to a considerable extent, saved a valuable subject from unmerited oblivion, though not from neglect. One of the worst reasons for the study of a subject in schools is that "questions are set on it", because it produces an attitude which leads to cramming.

The fact is that we have not hitherto evaluated the subject as an educational instrument, and there is now a danger that utility in the limited sense may receive too great prominence; those who feel most strongly would stress rather its educational value.

What we teach in the subject will be conditioned by our reasons for teaching it; the kind of textbook required will emerge from these decisions. It is clear that books written to meet the needs of the cartographer are only suitable in schools for purposes of reference. The school should aim at giving a sound grasp of principles to as many pupils as possible and, in any event, as those specializing in geography may be on the arts side, we must regard the basic mathematical equipment as of school certificate standard only.

Dr. Mainwaring has made a noteworthy contribution to the teaching of the subject: his book, ostensibly written as an introduction to map projections, aims at Higher School Certificate standard; actually he presents to us a well-considered scheme, admirable in plan and execution, likely to develop interest and to provide a suitable foundation for more advanced work.

He writes under headings: (*a*) the problem; (*b*) the process; (*c*) the application. The first deals with the relevant properties of the sphere, explains such terms as great circle, loxodrome and orthomorphic, and leads up to the aim of map projections. The explanations are accompanied by effective diagrams, the most striking showing great circle and west to east routes from Madrid to Peiping on Mercator and gnomonic nets; the section ends with six different nets between longitudes 0° and 15°.

Describing processes, projections are classified and dealt with as cylindrical, conical, zenithal, modified and arbitrary. Again the method is comparative and in each case a formula is obtained. In this connexion, it may be noted that the equation for the position of Molleweide parallels is proved but does not provide a ready means of solving the problem; may I suggest that a graphical solution has educational advantages over the use of the table? In the case of Mercator, it is suggested that the distance of a parallel represented by $R\int \sec\theta d\theta$ may be found by performing the summation $\Sigma_1^n \sec(x-\frac{1}{2})°$, where n is integral, using the 30′ column in four-figure tables of secants. Up to 80° this gives 139·56 equivalent equatorial longitude degrees, that is, 2·436 R.

The third section considers the choice of projection in relation to its use; it begins with a useful summary of the properties of those studied and is illustrated by well-chosen diagrams. The world is shown on four maps the uses of which are critically examined; two other world maps illustrate the advantage of interrupted projection. Africa and South America are exhibited on four nets with the same equatorial scale. North America is used to compare Bonne's and Lambert's, while the U.S.S.R. illustrates the use of two standard parallels.

It is to be hoped that those who adopt the book will spread the work over the two-year geography course; the contents will be best absorbed gradually, if their full implications are to be appreciated. Perhaps also the mathematical staff would like to make use of the book.

As a final note, there are still worlds to conquer in the field of useful projections; to encourage such research we cannot have too many interested students.

The author is to be congratulated on producing a book so uniformly good in text, diagrams and questions; the publishers, too, have done justice to it.

A. HINCKLEY.

An Atlas of Stellar Spectra

With an Outline of Spectral Classification. By W. W. Morgan, Philip C. Keenan and Edith Kellman. (Astrophysical Monographs, sponsored by the *Astrophysical Journal*.) Pp. vi+36+55 plates. (Chicago: University of Chicago Press; London: Cambridge University Press, 1943.) Price 60*s*. net.

THIS much-needed atlas defines a two-dimensional classification system of stellar spectra by means of a sequence of standard spectra, many of which are illustrated in the fifty-five photographic prints forming the main body of the work. The spectra were taken specially for the purpose on a small one-prism spectrograph attached to the 40-in. Yerkes refractor. The standard stars chosen, which are mostly brighter than the eighth apparent magnitude, are of types from *O*5 to *M*2, and were selected to exhibit a large range of luminosities. A given spectrum is considered uniquely classified when its spectral type (one of the conventional seven classes subdivided decimally) and its luminosity (one of five classes ranging from supergiants to the main sequence) are specified.

The "Outline" accompanying the prints gives a brief review of the taxonomic principles involved, and goes on to describe the criteria employed for both co-ordinates of the classification, and to tabulate the standard stars. No originality is claimed either for the system defined or for the criteria used: of necessity they are both evolved from work done, mainly at Harvard and Mount Wilson, by many previous investigators. The spectral types are closely correlated with colour, and will thus be invaluable in studies of interstellar absorption. The luminosities, when calibrated, will make possible the determination of accurate spectroscopic parallaxes on low-dispersion spectrograms.

The prints themselves are excellently reproduced and show well the lines, often quite faint, which are used for the classification of spectral type or luminosity. They are negative prints and can thus be compared directly with spectrograms in the observatory. The descriptions, though concise and lucid, are reproduced in a manual script which does not enhance the appearance of the Atlas, but the "Outline" is printed in the impeccable tradition of the "Astrophysical Monographs". It is not too much to predict that this work will quickly become a tool indispensable to every practical astrophysicist.

The Earth and Man

A Human Geography. By Prof. Darrell Haug Davis. Pp. xxiii+675. (New York: The Macmillan Company, 1942.) 21*s*. net.

AS geographers become more agreed on their province of study, they approach nearer to what might well be termed human ecology and find a field of observation that has been largely neglected in other studies. The analytical outlook, in geography as in other sciences that deal with living organisms, gives place to the more difficult synthetic outlook, which in geography is one of great complexity, because man is more concerned in improving, or at least in changing, his environment than in being dominated by it. In human ecology, the organism's reaction is far greater than in plant and animal ecology, and the risk of neglecting human influence on surroundings is a constant danger.

Prof. Davis has written a careful, though not profound, introduction to this aspect of geography, but he claims no further aim than the writing of a text-book for the early stages of university work, and this no doubt explains his general avoidance of problems in social geography. He has produced an admirable survey of the factors that decide the grouping and pattern of human distributions with special reference to North America. The rest of the world—especially the monsoon lands of Asia—are not neglected, but the book is primarily for American students. It is admirably illustrated with maps, diagrams and photographs, and has a full index. The bibliographical references might well be on a wider scale. R. N. R. B.

The Bushman Tribes of Southern Africa

By A. M. Duggan-Cronin; with an Introductory Article on the Bushman Tribes and Descriptive Notes on the Plates, by D. F. Bleek. Pp. v+15+40 plates. (Kimberley: Alexander McGregor Memorial Museum, 1942.)

ALTHOUGH the actual text of this book comprises only 14 pages, a great deal of reliable and interesting information is given on the physical characters and culture of the Bushman tribes. This information is supplemented by a useful map showing the distribution of the various tribal units. It would, perhaps, have been a useful addition to have provided a short key to the rather baffling system of phonetics employed in writing native words. Condensation was naturally necessary in so brief an introduction, but this brevity is in certain cases rather unsatisfactory. It is tantalizing to be told that: "In all tribes they make rain in some manner", but to be given no hint as to the procedure adopted in any tribe.

The story of these people is a sad one: "They are being gradually forced into servitude of black or white men, and absorbed into the coloured population of South Africa". The forty plates, most admirably reproduced from excellent photographs, constitute a permanent and valuable record of these doomed people. In them are preserved scenes from their daily life, records of many of their social and cultural activities and the physical characters of certain well-selected types. The National Research Board of South Africa and the authorities of the Alexander McGregor Memorial Museum are to be congratulated on the production of a publication of such perfection in the year 1942. F. WOOD JONES.

The Cathode Ray Oscillograph in Industry

By Dr. W. Wilson. Pp. xii+150+42 plates. (London: Chapman and Hall, Ltd., 1943.) 12*s*. 6*d*. net.

APPLICATIONS of the sealed-off cathode-ray tube to the field of radio have been previously well treated, so the author gains by concentrating on other applications, which are shown to be wide and valuable. Controlling electron beams in cathode-ray tubes, electron diffraction tubes, and electron microscopes exhibits many common features, and the author brings these and related topics up to date in book-form. He also shows that the sealed-off glass tubes and the metal continuously evacuated tubes have their separate fields of application and are not always competitors. He gives some of the latest electron microscope photographs, and shows how essential this new instrument is in many fields of research. It is unfortunate that the War has further retarded the development of electron microscopes in Great Britain, an opportunity which even private generosity has neglected. The text is well produced considering the present conditions, and includes the essential references. L. E. C. HUGHES.

ARTIFICIAL PRODUCTION OF DIAMONDS

By DR. C. H. DESCH, F.R.S.

THE claim of Moissan to have produced diamonds by the rapid quenching of molten iron or silver containing carbon in solution, causing solidification to take place in the interior of the mass under high pressure[1], was widely although not universally accepted, and found its way into the text-books. Le Chatelier, himself a very careful experimenter, was sceptical of the identification[2]. The later work by Sir Charles Parsons[3] tended to show that pressure alone was not responsible for the separation of carbon in the form of diamond, but that the entrapped gases played an essential part. In all these experiments the crystals obtained were very small, and were chiefly identified by their hardness, high refractive index, density and single refraction. It does not seem that Moissan's crystals were ever subjected to tests by any other worker, although Sir William Crookes[4] satisfied himself that small true diamonds had been produced. Moissan's own statements are categorical. Quantities of a few milligrams of black crystals prepared from silver and of transparent crystals from cast iron were burnt in oxygen, and after deducting the unburnt ash the weight of carbon dioxide obtained corresponded almost theoretically with the combustion of elemental carbon. The crystals had the correct density of 3·5.

Parsons used other methods. Besides repeating the experiments of earlier workers, with negative results, he produced instantaneous high pressures by means of explosives and by firing high-velocity rifle bullets into cavities containing the materials to be compressed. Experiments were also made in a 2,000-ton hydraulic press with electrical heating, producing only graphite. Some of the experiments with gases gave crystals which were apparently diamonds. On attempting to carry the process further, Parsons felt some doubts as to the identity of the crystals which he had formerly obtained, it being easy to mistake spinels (which are octahedral and optically isotropic, and in general appearance resemble diamonds, and are also highly resistant to the chemical agents used to dissolve mineral matter) for diamonds. It is true that on heating some of the crystals in a stream of oxygen flashes had been seen, indicating combustion, but it was found that in the long series of operations needed for the isolation of the crystals, particles of dust were liable to enter, and that it was these which were burning. Parsons, repeating his experiments with meticulous care, with the assistance of Mr. H. M. Duncan, found that his own crystals remained unburnt. The two investigators also repeated the experiments of Moissan and of others who had claimed to have produced diamonds, but again with negative results. Inquiries in France failed to locate any of Moissan's original crystals. Sir Charles Parsons, with the scrupulousness which was characteristic of him, submitted the whole of the evidence, including his own note-books and much correspondence with friends of Moissan, to the editor of NATURE, at whose suggestion the writer prepared a summary[5] leading to the conclusion that there was no satisfactory proof that diamonds had ever been obtained by any artificial process.

An earlier and less famous investigator who claimed to have produced artificial diamonds was James Bannatyne Hannay. In 1939, Prof. W. M. Travers[6] gave some account of the career of Hannay, a most ingenious and persevering experimenter, who as a boy was attracted by chemistry, and without any college training, becoming an assistant in the laboratory of a Glasgow chemical works, soon published a series of papers on improved analytical methods. Sir William Ramsay was a friend of his boyhood, and discussions between the two must have done much to stimulate Hannay's interest in research. He became works manager, but retired in 1876 on account of ill-health, and two years later became an assistant lecturer in Owens College, Manchester; actually he worked there only for two months, the reason being again bad health. He then took up private technical work, presumably as a consultant, and to this later period belong his most important investigations. He was particularly interested in high pressures and in the properties of substances at the critical temperature, on which he contributed papers to the Royal Society.

Hannay's work on diamonds[7] arose from his studies of the power of gases, especially water vapour, to dissolve solids under very high pressures, and he thought that if carbon could be brought into solution in some gas under high pressure, it might crystallize as diamond on cooling. In his first experiments he heated hydrocarbons with lithium in sealed glass tubes, the object being to bring about thermal dissociation of the hydrocarbon, absorbing the hydrogen produced in the alkali metal. Crystals which would scratch glass were occasionally obtained, and as these were octahedral, optically isotropic, showed the characteristic curvature of the faces, resisted hydrofluoric acid, and burnt in oxygen, he concluded that they were true diamonds. However, he thought it advisable to use higher temperatures and pressures than could be reached in glass tubes, and a change was made to tubes of wrought iron. The tubes were 20 in. long and ½ in. bore, but the thickness of the walls, at first only ¼ in., had to be progressively increased to more than 1½ in., on account of bursting. Various plugs were tried but invariably leaked. It was found necessary to close the open end by a blacksmith's weld, the modern methods of welding not having been invented, and as this had to be done on a short length of tube two thirds filled with volatile liquid, it is not surprising to read that "It requires great skill on the part of the workman, and it is only one man in a hundred who can perform the operation with invariable success". The sealed tubes were heated in a coal-fired reverberatory furnace. All but a few of the tubes burst during heating to redness; and as on many occasions the furnace was wrecked and had to be rebuilt, Hannay's perseverance must be considered as extraordinary. Out of more than eighty experiments only three were successful. Tubes bored from solid steel bars failed badly.

Hannay had been seeking commercial uses for 'bone oil', a mixture of nitrogenous compounds obtained by distillation from bones, and this occurred to him as a possible solvent for the experiments on diamond. Its volatility (the fraction boiling between 115° and 150° was used) made welding still more difficult, while "the continued strain on the nerves, watching the temperature of the furnace, and in a state of tension in case of an explosion, induces a nervous state which is extremely weakening, and when the explosion occurs it sometimes shakes one so severely that sickness supervenes". In spite of these difficulties, Hannay obtained some positive results, using a

mixture of 90 per cent of "paraffin spirit" and 10 per cent of bone oil with the addition of solid lithium. The hard residue was crushed, and was found to contain some transparent crystals which were identified as diamond. A combustion carried out on 14 mgm. gave 97·85 per cent of carbon.

In spite of the small number of successes, it is difficult to believe that Hannay was mistaken in his identification. As his solid residues contained nitrogen, he was inclined to believe that the diamonds owed their origin to the nitrogenous compounds used and not to the hydrocarbons, a point which would have an important bearing on the origin of the natural crystals. Although he announced his intention of making further experiments, no later paper on this subject appeared, although he published work on other subjects so late as 1894.

Moissan attempted to repeat Hannay's experiments, but could not succeed in welding the tubes. Parsons also tried the same materials and pressures, but without success, and the work might have been forgotten but for the fortunate fact that twelve of the minute crystals obtained by Hannay in 1879–80 had been deposited in the mineral collection of the British Museum (Natural History). None of the crystals obtained by either Moissan or Parsons has been traced.

The whole subject has been transformed by recent work with X-rays. Mrs. K. Lonsdale and Mr. F. A. Bannister[8] were able to examine by X-ray methods the crystals preserved at South Kensington, and found some of them to be true diamonds. What, however, was still more remarkable was that they showed the characteristics of the rare (type II) diamond described by Sir Robert Robertson and his colleagues[9], which differ profoundly in optical and electrical properties from the normal type I. One was definitely identified by its X-ray pattern as of type II, while the others showed the highly laminated condition which is associated with that type. Since type II only occurs in about one per cent of natural diamonds, the probability that Hannay's crystals were actually obtained artificially is greatly strengthened, and the accuracy of his statements vindicated. It is clear that the new observations re-open the whole question, and that, in spite of the failure of Parsons and Duncan to convince themselves that they had obtained true diamonds, and their consequent rejection of earlier work, it may prove that the methods of high pressure and high temperature common to the work of Hannay, Moissan and Parsons do actually succeed in converting a minute proportion of the carbon contained in the materials into diamond, although the factors determining such a transformation remain very obscure, while the fact has to be borne in mind that all diamonds, exposed to a sufficiently high temperature, are changed to graphite. A very old problem thus comes again into prominence, but with the advantage of experimental methods of rapid identification which were not available to the earlier workers.

[1] Papers in *C.R. Acad. Sci.* from 1894 onwards. Summarized in "Le Four électrique"; English translation, "The Electric Furnace" (Easton, Pa., 1920).
[2] Le Chatelier, H., "Leçons sur le carbone" (Paris, 1926), p. 24.
[3] Parsons, C. A., *Proc. Roy. Soc.*, A, **79**, 532 (1907); *J. Inst. Metals*, **20**, 5 (1918); *Phil. Trans.*, A, **220**, 67 (1920).
[4] Crookes, W., "Diamonds" (London, 1909).
[5] NATURE, **121**, 799 (1928).
[6] Travers, M. W., *Chem. and Ind.*, **17**, 507 (1930).
[7] Hannay, J. B., *Proc. Roy. Soc.*, **30**, 188, 450 (1880).
[8] Bannister, F. A., and Lonsdale, K., NATURE, **151**, 334 (1943).
[9] Robertson, R., Fox, J. J., and Martin, A. E., *Phil. Trans.*, A, **232**, 463 (1934).

NATURE AND USES OF SEAWEEDS*

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IN the last fifty years or so there has been much progress in our knowledge of seaweeds, but until comparatively recently, mainly from the botanical point of view. Until this century, botanists had been chiefly concerned with nomenclature and with the major facts of structure and reproduction of a few commoner types. But early in this century, newer lines of investigation were being developed, involving the systematic analysis of vegetational units and the study of the complex relations between the plant and its environment. Mr. A. D. Cotton has made an ecological survey of the marine algæ of Clare Island, off the coast of Ireland. This study, the first of its kind by a British author relating to the algæ, became and has remained a classic for other workers in this field.

Another and rather different line of advance during the last thirty to forty years has been in the study of the life-histories of the marine algæ, stimulated in Great Britain by the work of Lloyd Williams (1906) and in France by that of Sauvageau (1915). Lloyd Williams found that in the brown alga *Dictyota dichotoma*, Lamour, two generations, externally similar, followed one another, each devoted to a different kind of reproduction, one with sexual, the other with asexual reproduction. He also found a definite rhythm of reproduction, closely related to tidal phenomena. Sauvageau made the even more striking discovery that the innumerable swimming spores produced by the different species of Laminaria (reckoned by Yendo as about 84,000 per square millimetre) could be made to germinate, when they developed into minute branched threads requiring high magnification for observation. These ultimately gave rise to gametes, which after fertilization reproduced the early stages of the original type of plant.

The effect of this discovery on the botanical world was far-reaching. It has been found that this type of alternation is characteristic of the whole family of Laminarias, though by no means limited to it. In many apparently annual types, like the familiar 'sea bootlaces' (*Chorda filum*, Lamour), although the visible thallus or 'bootlace' dies down at the end of the summer, a microscopic sexual generation is produced and carries on the cycle unseen beneath the waters during the winter months.

In respect of the red algæ, Yamanouchi followed the still more complicated life-history of *Polysiphonia violacea*, Harv. (1906), and this became the forerunner of many similar investigations, notably those of Svedelius (of Copenhagen) and of Kylin (of Bergen). Although most red algæ have alternation between two similar plants, it is beginning to be realized that others have great difference in form between their alternate generations, even when both are equally visible to the naked eye. To establish their identity is then no easy matter, for most marine algæ are difficult to cultivate under artificial conditions. It is not surprising that nomenclature of the marine algæ is in a backward state, since in the past it has been founded largely on the observation of material (often dried) apart from a knowledge of life-cycles,

* Substance of a paper read before the Royal Society of Arts on May 12.

or of other differences in form brought about by the influence of a particular environment. There is, as yet, no systematic record of the algal vegetation of our coasts. Such accounts as are available relate to particular localities, usually to summer resorts where rocks are relatively accessible, or to regions within the sphere of influence of marine biological stations, like that at Plymouth or at Port Erin, in the Isle of Man. Little is known of the interaction between the animal and plant population of the shore.

Whereas some seaweeds are permanently submerged in pools or in deep water, the majority are amphibious, in that they spend part of their lives under water, part exposed to the air, owing to the receding of the tide. Unlike some amphibious animals, they are fixed to some substrate, so that they must endure, at least temporarily, all atmospheric vicissitudes. They may be heated by the sun, cooled by wind or frost and dried by the action of wind and sun together. The sea-water adhering to them may be diluted by rain or concentrated to brine by evaporation. The time of exposure varies with the height of the tide and the position on the shore. Those near the upper limits have longer exposure, and unless they are to be found in fairly deep pools, only species which are resistant to desiccation can survive in this region. For the same reason, in hot climates, intertidal vegetation is much more sparse than on temperate shores. The middle regions of the shore are the most densely populated by both animals and plants, and here competition for space and light is the keenest; while at the lower limits, the depth of water is such that there is too little light for any but shade plants (mostly red algæ) or brown ones like the Laminarias with long stipes which bring the flat fronds up towards the surface.

On the whole, in temperate climates there is a marked tendency towards zonation—at low water, the higher and middle regions of rock or shore being predominantly brown, from the more numerous of brown algæ, the lower regions red or brownish-red. The underlying causes of this zonal distribution has of recent years been the subject of much discussion.

All this is not merely of general or academic interest. If, as seems not unlikely, seaweeds may become an asset of some commercial importance, conditions of their growth, regeneration and harvesting must be more fully explored. In suitable localities and on suitable shores it may then be worth while to cultivate the more profitable kinds. Something of the kind is, indeed, already being attempted on a small scale in the so-called Fucus farms of Northern Ireland, where the harvest is utilized locally for manuring the fields. These farms are located in somewhat sheltered bays where, at low water, there is a flat stretch of sand strewn with large stones, boulders or rocks. The kind of alga which develops depends partly on the nature of the anchorage, partly on the position with respect to tidal range. Thus the boulders and larger stones of the upper middle tidal zone become covered with Ascophyllum; the smaller stones wedged between bear *Fucus vesiculosus* L., the common bladder wrack; while at lower levels both stones and rocks bear *F. serratus* L.

These three species form the bulk of the harvest, and when cut are regenerated from sporelings; but apparently two or three years must elapse between successive harvests from the same area, and no attempts have been made, so far as I know, to improve the yield or to shorten the period of regeneration and maturation; more stones are sometimes added, however, and this demands a certain amount of judgment as to size and suitability. At the present time, a number of research workers at Port Erin are engaged in studying the growth-rate and reproduction of certain seaweeds of possible future importance with a view to their more rational harvesting, and it is to be hoped that these and other investigations will be continued and expanded in post-war years.

Seaweeds have been used extensively in the East for many years; in Japan especially for food, manure and glue. Early in this century, when commercial developments were visualized, a definite cultivation was inaugurated there. For this purpose, suitable rock-surfaces were cleared of weed during the period of reproduction. After a time, the water being full of their spores, a new crop appeared, which successfully established itself in spite of competition with other kinds which usually arrived first.

The Japanese botanist Yendo was instructed to study and report on the conditions for success and also on the causes of failure in certain areas. With the help of this report and the practical experience of fishermen who were employed in the cultivation, instructions were drawn up and circulated as to planting and harvesting the appropriate seaweeds. On certain reefs, constantly removing crops of Laminaria favoured the spread of a useless plant, Phyllospadix (one of the few submarine flowering plants), which covered the surface with its undergrowth and smothered the young plants of Laminaria. The removal of the Phyllospadix was therefore made compulsory, a special tool being designed to facilitate the periodic weeding.

Yendo pointed out that seaweeds, like other plants, had their peculiarities which must be considered: for example, Gloiopeltis, from which much glue is made, flourishes best on smooth, hard surfaces, in positions where there is spray or foam; on the other hand, rough surfaces suit most seaweeds, Laminarias requiring a hard rock, like quartzite, pitted with numerous depressions. Porphyra is grown by planting small twigs obliquely in crevices in areas where the salinity is high. This gives the greatest number of sporelings: the twigs are then transplanted to places where the salinity is lower, in order that the finest fronds should develop from the sporelings.

Not all marine plants are seaweeds in the stricter sense of the word. Zostera, the eel-grass, for example, which occurs in relatively quiet waters, is a flowering plant, producing flowers and fruits beneath the waves. The true seaweeds, on the other hand, are plants of a much lower order in the evolutionary scale of plant life, as will have been realized in connexion with the life-cycles to which reference has already been made.

The great differences between the marine algæ and the flowering plants are seen, however, in many other features—for example, in their general organization, the plant having no root system, no buds or flowers, and, of course, no seed production. It is also seen in their construction, which has little in common with that of flowering plants even when these, like Zostera, have the same habitat.

The building of a structure may be said to depend on three things—on materials, the building unit and on design. The building materials of the seaweeds are various mucilaginous and gelifying substances, cellulose playing little or no part in the composition of their walls. The unit of construction is the branched thread or filament, that is, a chain of cells rather than single cells aggregated into tissues. The whole

structure is fabricated of variously interwoven threads, some of which may have walls of considerable thickness. Some of the threads send out lateral branches, the tips of which become compacted together, giving a firm exterior to the plant. In many surf plants, the threads become intricately intertwined, as the thallus is tossed about by wave action. Mucilaginous substances, believed to be derived from the cell walls, cement the whole together. The architecture of most seaweeds is such as to give flexibility with either elasticity and extensibility as in Ascophyllum and Himanthalia, or with a certain tensile resistance as in Fucus. The peculiar wall material also serves another purpose, readily absorbing water and retaining it with tenacity when exposed to drying. It is these wall substances which promise to become of great commercial importance.

The biochemical features of algal products have been explored from several angles—their pigmentation, their metabolic products and their wall substances differing considerably in the three great groups. Most of this lies beyond the scope of the present paper; but I should like to note in passing the success of a plant biochemist, Dr. Paul Haas (1931), in capturing and identifying the source of the characteristic smell of one of the common red seaweeds, *Polysiphonia lanosa*, parasitic on the brown alga *Ascophyllum nodosum*. The fresh alga was placed in a flask, kept at 30° C. by means of a water bath. Air was drawn through and carried over a volatile substance, which dissolved in water, alcohol or acetone. Afterwards this was found to be identical with methyl sulphide.

Utilization of Seaweeds

Generally speaking, seaweeds are utilized in three principal ways: in connexion with agriculture, as food or medicine, and for industrial purposes.

1. *Seaweeds in agriculture.* In agriculture, seaweeds are used as fodder or as manure. The seaweed may be fed fresh (sheep, for example, are allowed to graze on the rocks at low water in the Orkneys). In the north of Scotland, Pelvetia is brought to the boil and after addition of oatmeal is used to feed calves. Dried seaweed, ground to a meal, is used in some districts or, alternatively, the fresh seaweed is stored in layers with hay between, forming a kind of silage as winter feed. *Laminaria saccharina* was fed to horses with varying success in France during the War of 1914–1918. Reports of the results are not always in accord, perhaps because of seasonal variations in the food value of the alga, since the sugar content is at a maximum in the autumn and it seems that the sugar (stored as laminarin) is probably the most easily digested of the constituents. In New Zealand, seaweed (Macrocystis, Hormosira) is found to benefit cattle grazing on poor pasture land. In America, seaweed meal has improved health and fertility in cattle and in chickens, when fed as a small proportion of the daily diet.

The use of algæ as manure in maritime situations is widely practised. It is well known on coasts of Brittany, on various coasts of Ireland, in the north and west of Scotland and on coasts of northern Europe. Naturally, driftweed is largely collected for the purpose, but harvesting the cut seaweed is also practised where the coast is suitable. In north-west France the collection of algæ has been regulated by statute for some hundreds of years. The manurial value is probably due to the organic constituents, which provide bulk for the soil, as well as for the mineral salts. There is little nitrogenous value in most seaweeds, but the different kinds of laver (Ulva and Porphyra) are said to be exceptional in this respect.

2. *Seaweeds as food or medicine.* The use of seaweeds for food has been known from very early times. They are greatly valued in the East—in Japan, coasts of China and Malay; but they are also used on the north and north-west coasts of Europe.

Laver (*Ulva latissima* and *Porphyra laciniata*), dulse (*Rhodymenia palmata*) and murlins (*Alaria esculenta*) are eaten as vegetable on the coasts of Ireland and Scotland and no doubt elsewhere, and may be familiar in this capacity to a number of people. The name of sea lettuce for *Ulva latissima* is suggestive.

Pink laver is produced commercially in Japan, and the washed, pressed fronds are regarded as a delicacy. It is used under the name of *akusanori* for soups, as a vegetable, or may even be eaten raw. The sample I happen to possess claims to be especially fine—but it seems rather tasteless to the Western palate. In Great Britain, probably carrageen moss (*Chondrus crispus* and Gigartina spp.) is the most widely utilized of seaweed products, valued for the jelly-like nature of its hot-water extract. In the War of 1914–18, carrageen was in demand to replace gelatin, which was in short supply.

Little seems to be known with any certainty as to the food value of even the most edible weeds. It is usually considered that their mineral content is of value, especially the iodides, which are characteristic of many brown and some red kinds; their gelatinous substances are probably not digested by man, but may be useful in providing bulk without irritation. There are algæ like *Laminaria saccharina* and *Alaria esculenta*, which seasonally store sugars, but it seems doubtful whether these particular sugars can be digested, at least by human beings. It is on record, however, that the digestive juices of snails and limpets are very efficient in this respect.

Seaweeds as food have never been very popular in England, but several preparations are marketed at the present time and sold as "seaweed salt". This is recommended as giving a daily quota of iodine in natural form, to maintain health or to correct deficiency in those with a tendency to goitre. Some of these preparations claim to be the dried and finely powdered weed. In conformity with this claim, the powders, on moistening, swell to a gelatinous mass which has a taste decidedly suggestive of seaweed. The iodine content of certain seaweeds is remarkable in that it has to be derived from the sea water, in which only traces occur. The algæ are believed to absorb water over their whole surface; they must have the power not only to absorb the traces present, but also to accumulate them within. The physiological mechanism of this accumulation is little understood.

Among the brown algæ, the Laminariaceæ are relatively rich in iodine, but the Fucaceæ are also used as sources of iodine in some localities. A number of red algæ also store iodine (for example, species of Iridea and Asparagopsis), while a few have special enlarged superficial cells rich in iodides: these red algæ, however, do not occur in sufficient abundance, at least in Europe, to serve as a source of iodine on any commercial scale.

3. *Commercial products.* The manufacture of potash and other substances from kelp* (derived from the larger brown algæ) fell into disuse in the latter part of the nineteenth century, when cheaper sources were discovered from mineral deposits. In the present century, interest has grown in the algæ as a source of mucilaginous substances utilized in many ways, especially in Japan, Great Britain and the United States. These mucilaginous substances can be divided roughly into two classes with differing chemical and physical properties: those from the brown and from the red algæ respectively.

The mucilaginous products of the higher brown algæ can be extracted by boiling the fresh material with a dilute solution of sodium carbonate. After a time, the tissues swell and lose their shape; the mass is then filtered through cloth, and on acidifying there forms a thick, slimy substance recognized by Stanford in 1862 as of definite chemical composition and named by him first algin, later alginic acid, since it formed a series of metallic salts, like a true acid.

In recent years, algin and its derivatives have been utilized for many commercial purposes. A study of the many patents granted in this period reveals something of the progress which has been made both on the technical side and in the chemical knowledge on which that progress must be based. It has been found, for example, that when treated with vulcanizing agents, such as carbon disulphide or carbon tetrachloride, algin becomes a rubbery mass, which has been used to make rollers for typewriters, among other things.

By violently agitating an alkaline solution of algin with which a small proportion of tannic acid has been mixed, the whole emulsifies and may be poured upon a glass or polished surface, giving a transparent film resembling 'Cellophane'. It is claimed that this film is cheap, almost non-inflammable and less influenced by light than true 'Cellophane', which is apt to become very brittle. It has already been widely used as an inexpensive transparent wrapping for various classes of goods, or, at least, it was so used before restrictions on wrappings were in force.

The purified alkaline extract of the fresh seaweed may, alternatively, be forced through a fine aperture, forming a viscous thread which is then spun into a bath containing a mixture of furfurol, caustic soda, formalin and other substances. By this means a kind of 'artificial silk' is produced, which after further treatment is washed and finally sized with an ammoniacal solution of algin under pressure.

This thread, however, as first produced, was not strong enough for weaving, and moreover was not sufficiently resistant to soaps containing a proportion of alkali. Further processes involving treatment of the thread with salts of chromium or beryllium are alleged to have overcome these difficulties. The chromium salts, being coloured, were not so suitable for subsequent dyeing, but the beryllium salts appear to be free from this objection. The strengthened thread so obtained will, no doubt, be tested in due course for weaving.

The Japanese claim to have produced an artificial wool from gulfweed (Sargassum spp.) by spinning the viscous thread into a bath, which had a crimping effect.

In recent years, salts of alginic acid have been obtained from species of Laminaria collected on the Atlantic coasts of Scotland. From this source, the firm of Albright & Wilson have been able to market a purified form of sodium alginate which has been given the trade name of 'Manucol'. The white powder dissolves in water to form extremely viscous solutions which are tasteless, odourless and almost colourless. It is claimed that these powders or their derived products have been utilized in connexion with a variety of industries, including production of food and medicines, and the manufacture of cosmetics, textiles, transparencies and plastics.

Alginates may be added to milk previous to the manufacture of milk powders; in this way, the milk can be reconstituted by the addition of water, without causing sedimentation. Cocoa may be rendered more 'soluble' by a similar addition.

The colloidal properties of alginates render them especially suitable as a base for creaming agents, for car polish and even for boiler feeds to prevent the deposition of 'fur'. In these and a number of other commercial products, alginates behave as 'protective' colloids, helping to keep in suspension or emulsion particles which would otherwise tend to settle as a sediment.

Although so many uses have been found for the salts of alginic acid, the chemical composition of the acid itself has been a subject of controversy. Stanford concluded that the molecule was a large one, including nitrogen ($C_{12}H_{20}N_2O_{11}$), but later work with purified materials has established that it is a polymer of *d*-mannuronic acid. Experiments of Bonniken appear to indicate that treating the alkaline salts with astringent agents causes a progressive polymerization of the original algin molecule, giving longer and more complex chain structure. It is these long-chain molecules which are important for the production of textile threads and are susceptible to contraction, giving the possibility of a crimping effect.

Two classes of colloidal substances can readily be extracted from red algæ, namely, mucilages and gels. The former may be dissolved out with cold or tepid water, the latter by boiling for a short time.

In Japan, at Osaki, a kind of seaweed glue called 'funori' is made from species of Gloiopeltis (chiefly *G. coliformis* and *G. intricata*). It is used for adhesives and for sizing paper, fibre or cloth. A more valuable product is agar-agar, the commercial name given to the gelatinous substance extracted by boiling water. During the last two decades, agar has been widely used in connexion with foods and medicines. As a laxative, it absorbs and retains water, besides acting as a lubricant. It is almost universally used as a basis for bacterial and fungal cultures, resisting liquefaction. Recently, however, a strain of bacteria, *Vibrio agarlyticus*, has been isolated which liquifies agar but not cellulose.

By far the greater part of the world's supply of agar came from Japan, but a considerable quantity has also been manufactured in California, though much is not sufficiently pure for bacteriological purposes. At the present time, investigations are being carried out in the United States and other countries, with the view of developing local supplies. The rich algal flora of the coasts of South Africa and New Zealand and of the west coasts of North America and Canada offer many possibilities, but even in the U.S.S.R. during the last ten years, an agar-producing industry has apparently been developed, utilizing algæ which occur on their maritime coasts and on the shores of the Black Sea. It has recently been announced that agar suitable for bacteriological purposes has been

* 'Kelp' was the name originally used for the ash of the larger brown seaweeds after burning. In America it has also been applied to the various brown algæ used for this purpose.

obtained from certain seaweeds in South Africa, New Zealand and in Britain. This is being further explored.

To obtain a pure agar, the freshly collected algæ are bleached in the sun for some days, the process being hastened by sprinkling at intervals with fresh water. The bleached algæ are then boiled with water (Japan) or treated with steam (United States) and the resulting mass strained through cloth. The clear liquid is poured into shallow troughs to set, and the jelly cut into narrow strips. In Japan, the process is carried out in cold weather, so that the strips contract, expelling water; in the United States the same result is obtained by artificial refrigeration. In either case, the expelled water is drained off, and the remaining jelly dried and shredded for packing.

Agar prepared in this manner has been analysed and is described as "a galactan with sugar units of unusual structure". Carrageen mucilage from *Chondrus crispus* is a "polysaccharide ester of sulphuric acid by the acetolysis of which two galactans were isolated". Both these products are water soluble. According to Tschudy and Sargent, the two American species of Gigartina require a preliminary soaking and subsequent boiling in lime water or 2 per cent calcium chloride in order to extract a substance giving a firm jelly. Subsequent treatment (straining, cooling and drying) appears to be the same as for the water-soluble derivatives of other types. It appears, therefore, that a number of different but probably closely related substances with similar physical characteristics are included under the general term agar. The amount which can be extracted appears to be very variable. One of the best sources, the Japanese *Gelidium amansii*, is said to yield 25–35 per cent of its dry weight as agar.

The commercial utilization of seaweeds raises many issues. Having regard to present difficulties of overseas transport, it would seem natural to seek supplies from our own shores, possibly from the west and south-west of England, and the west and north-west of Scotland. The shores must be far enough from towns to escape serious pollution from sewage, yet sufficiently accessible to the collector and to transport for the material collected. For most purposes, probably, the dried seaweed would suffice, and it could be washed and dried on the spot, before packing.

When harvesting is regularly practised, it may be necessary to restrict the season of cutting and to regulate it in such a way that regeneration may occur by natural means. Much more information is needed as to the requirements of seaweeds for healthy growth and the reasons underlying the present distribution, especially of useful types. It is very probable that advances along these lines would lead to successful cultivation of desirable types like *Gracilaria confervoides*, *Ahnfeldtia plicata* or *Gelidium corneum*, which are fairly common in some localities, or of *Chondrus crispus* and *Gigartina stellata* Batt., which are already known to be abundant in certain areas.

The commercial utilization further demands much work on the biochemical and technical side before the final stages of marketing can be reached. We thus require the services of the botanist, the ecologist, the biochemist, the technician and the financier. Yet the last word remains with the botanist, who combines the experience and judgment of a systematist with the practical knowledge of the ecologist. For, in order that analyses may bear fruit, it is necessary that the right type of alga should be recognizable and recognized, its course of life understood and its reproductive periods utilized to the full.

PHYSIOLOGY OF THE LUNG

By Dr. O. A. TROWELL,
University of Edinburgh

PROF. B. Narayana, in his presidential address to the Physiology Section of the thirtieth Indian Science Congress held in January last, took as his subject "The Growth of Physiology as an Experimental Science". After tracing the history of experimental physiology from its origins with Ludwig and Claude Bernard, and giving some account of its current status, he proceeded to a review of recent work on the vasomotor and bronchomotor mechanisms of the lung, which subject he chose as an illustration of modern methods and the modern outlook in experimental physiology. This field of research has been developed chiefly by Prof. de Burgh Daly and his colleagues, first in Birmingham and later in Edinburgh. Prof. Narayana himself collaborated in some of the work in Edinburgh, and later he and his colleagues in India have made further contributions of their own.

In considering the physiological activity of the lung itself, we may remark that its respiratory movements are merely a passive response to changes in the capacity of the chest, that the gas exchange between blood and air is simply a process of physical diffusion, and that the only known physiological variables intrinsic in the lung itself are the calibre of the blood vessels and the calibre of the bronchi. The calibre of these tubes is controlled by the plain muscle fibres which form a large part of their walls. Vasomotor and bronchomotor changes, therefore, seem to be the principal intrinsic activities of the lung which call for investigation, and this is the field which Daly and his colleagues have successfully explored.

In the physiological investigation of any bodily organ there are, broadly speaking, two alternative lines of attack available. The first, or analytical, method seeks to isolate the organ in question from the disturbing influences of the rest of the body, preferably by excising it altogether, and, keeping it alive under fully controlled but somewhat artificial conditions, to analyse its functional responses to controlled stimuli. The second, or synthetic, method seeks to establish the part played by the organ in the integrated life of the whole animal, how it influences, and is influenced by, changes occurring elsewhere in the body. In the first method natural conditions must be sacrificed in order to secure full experimental control, and the results obtained indicate the physiological potentialities of the organ rather than its normal behaviour in the whole animal. The second method sacrifices full experimental control in order to maintain a natural condition of the organ; the results generally lack the scientific certitude associated with the former method, but when significant they reveal more truly the role of the organ in the normal life of the animal.

Daly, in his work on the lung, adopted the analytical approach. His success has been due in the first place to the development of a skilful technique whereby the lungs can be removed from the body and kept alive for several hours under artificial conditions, the blood circulation and respiratory movements being maintained by suitable pumps. The lung inflation, blood pressure, blood flow and other factors were under complete control and were recorded continuously. A second factor, no less

essential to success, arose from an anatomical consideration. It was known that in addition to their main supply from the pulmonary artery, the lungs also receive a small vascular supply from the systemic circulation by way of the bronchial arteries. These vessels supply the walls of the bronchi and those of the pulmonary arteries together with their associated nerves and ganglia. In preliminary work, Daly traced the territorial distribution of the bronchial vascular system in the lung; he showed that there is a capillary anastomosis between the bronchial and the pulmonary circulations in the region of the respiratory bronchioles, and he was the first to realize the physiological importance of the fact that the arterial and bronchial musculature, with their associated nerves, the very tissues the responses of which were to be the subject of investigation, received their oxygen supply and nourishment exclusively from the bronchial circulation. He therefore devised a method for the separate perfusion of the bronchial circulation as well as the pulmonary circulation in the isolated lung. Previous workers on the isolated lung had perfused only the pulmonary vessels, and their usual failure to obtain vasomotor responses was therefore only to be expected. The technique of the 'isolated perfused lung' had to be perfected before any worthwhile investigations were feasible.

The results obtained have provided convincing evidence of the existence of a nervous vasomotor control of the pulmonary circulation; the earlier evidence had been unsatisfactory. The vasomotor and bronchomotor responses to the stimulation of various nerves and to the injection of various hormones and drugs were fully investigated in several species of animal—guinea pig, cat, dog, pig and monkey. The particular responses obtained varied considerably from species to species and also under varying experimental conditions in any one animal, so much so that no simple or uniform picture emerges. This is characteristic of modern physiology; the more intensively a phenomenon is investigated the more complex is it revealed to be, and the final picture ever recedes from sight. Every day the apparently simple phenomena of classical physiology grow more and more complex as they are subjected to the more searching analysis of modern technique.

With regard to the vasomotor responses, stimulation of either cholinergic (vagus) fibres or adrenergic (sympathetic) fibres most commonly produced vasoconstriction, but in certain defined circumstances vasodilation could result from either. Injection of acetyl choline or adrenaline gave parallel results. The bronchomotor responses were similarly variable, depending on the species and the experimental conditions. The detailed findings are of considerable interest, particularly in their relation to current theories of chemical transmission in the autonomic system, but space does not permit their discussion here.

Perhaps the most significant outcome of this work is to be found not in the detailed findings, but rather in the very variability of the responses obtained; the fact that a given nerve or a given hormone can produce in certain circumstances a constriction and in other circumstances a dilatation in one and the same preparation is in itself of the greatest physiological importance, and suggests many hitherto unthought-of possibilities with regard to the occurrence of similar changes in the whole animal. The problem of the bronchospasm in asthma, for example, can be considered in quite a new light as a result of these researches. It must always be remembered, however, that the isolated perfused lung is surviving under highly abnormal conditions and probably its behaviour is correspondingly abnormal; so the transference of these results to the whole animal and to man is at present not justified. The potentialities of the lung have been revealed; to what extent they operate in normal life remains to be discovered.

Prof. Narayana concluded his address with a plea for the further development of experimental physiology in India. He himself is already contributing to this end in the active research which he has initiated in his own department at the University of Patna. We can wish our Indian colleagues well in their pursuit of the common ideal, and we shall look forward to their contributions to the further growth of the science.

OBITUARIES

Mr. William Hartree, O.B.E.

A REMARKABLE fact about William Hartree, who died on April 27, 1943, was that his first scientific paper appeared (in 1920) when he was fifty, his last (in 1941) when he was seventy-one. In those twenty-one years he published ten papers alone and thirty-six in collaboration (in *J. Physiol.*, *Proc. Roy. Soc. A* and *B*, *Phil. Trans. A* and *B*, *Phys. Rev.*, *J. Sci. Instruments*, *Proc. Camb. Phil. Soc.*, and *Biochem. J.*).

In the strictest and best sense, Hartree was an amateur; he worked for love of his work and, I think one dare say, of his collaborators. But he worked also with the intensity and pride of a craftsman in his job, and for all his steadfast modesty, he knew, like a craftsman, when he had done it well, and he worked with quite inflexible devotion. During the War of 1914–18, at Whale Island, he said—almost seriously—that he was going on strike for more work and less pay: his pay could not have been much less nor his work more. I had to stop him then from trying to get into the army at forty-seven—because he was enjoying that work too much! Later, at Cambridge, when I pressed him once to take a holiday, he wrote me next day "I have taken a holiday to-day—made a new kind of experiment"—the only kind of holiday he liked.

Hartree was known, except by his work, to very few: he never attended meetings: he wanted no credit or praise for what he did. He almost seemed to prefer to do a difficult job well rather than make it easy. He was ready to face the most laborious calculations in order to obtain a result; he almost resented at first any improvement in technique which made calculation simpler. In his work with me on the physiology of muscle he reckoned that he had written down between 10^7 and 10^8 figures, and we very seldom discovered a mistake. He was always ready to take a sporting chance to see what he could make of a new job—as when he took up research on A.A. gunnery in 1916, when he turned (a mathematician and engineer) to experimental physiological research in 1919, when he took to the theoretical study of atomic structures in 1933 and to the numerical solution of certain partial differential equations, concerned with motion in a viscous fluid, in his last years. Yet in some ways he was very conservative; for thirteen years his chair in the physiological laboratory at Cambridge, where he did his arithmetic,

was precariously balanced on four old fuse-tins of the last war, when it would have been easy to lengthen the legs or even to screw the fuse-tins on! He was not an original or brilliant thinker, though he was obstinately independent when he knew he was right; he preferred always to help others, and this note is written, in gratitude and affection, by one whom he helped full-time for seventeen years.

Hartree was born on April 8, 1870, the son of John Penn Hartree, F.R.C.S. His mother was the daughter of Samuel Smiles, author of "Self Help" (1859) and many other works. J. P. Hartree was the son of an able engineer and, like his son, was educated at Trinity College, Cambridge; he obtained a first-class in the Natural Sciences Tripos (1865). Later he practised, and attended various hospitals in London, but when his son Willie was six years old moved to Belfast. He passed on his temperament and abilities to his son: retiring, silent, able, kindly, with the same high standards and perfection of work. He was a well-known member of the Alpine Club.

From Belfast, W. Hartree went to Tonbridge School and later to Trinity College, Cambridge, where he was eighteenth Wrangler in 1892. Then after a short apprenticeship in electrical engineering he lectured and demonstrated in the Engineering Department at Cambridge until 1913. He married in 1895 his cousin Eva, daughter of Dr. Edwin Rayner of Stockport (sometime treasurer of the British Medical Association) and of J. P. Hartree's sister, and sister of Dr. E. H. Rayner, late of the National Physical Laboratory. Mrs. Hartree has been mayor of Cambridge (his friends always wondered what sort of 'mayoress' Hartree made!) and has done distinguished public work in many fields. Of their five children, only one survives (Prof. D. R. Hartree of the University of Manchester); a younger son who had been a 2nd lieutenant in the Royal Artillery and had worked, like his father and brother, at Whale Island on A.A. gunnery, died soon after the War of 1914–18.

In 1913 Hartree retired and went to live in Surrey, where he busied himself with experimental wireless. Early during the War of 1914–18, he joined up for work with the G.P.O. and served—with his usual devotion and humility—as a telegraph linesman. In 1916, when R. H. Fowler and I were starting up what later became the Anti-Aircraft Experimental Section of the Ministry of Munitions, Hartree, at E. H. Rayner's suggestion, came to join us. It was hard to believe that this shabby, middle-aged linesman, offering to work for love, was an able mathematician and engineer—but he was, and much more. Whenever a job of hard work had to be done on time, whenever some difficult observations were to be made, whenever something was to be fetched or carried, whenever long hours and discomfort to be endured 'at the far end of the base', Hartree was there. Nobody could see shell-bursts so nearly into the sun, nobody could record what he saw so accurately and quickly, nobody could interpret the results so well, nobody would come so early to the office or stay so late to work them out. Quietly, one day, he improvised a long-base height-finder out of some wires, posts and a steel tape. It came to be called the Hartree height-finder and was used extensively by the troops until sufficient monostatic optical height-finders were produced; perhaps that was why he was given an O.B.E. Once he was arrested on the beach near Great Yarmouth during a gun-trial, for communicating with the enemy by means of an ordinary field telephone laid along the shore. Once, he was driven to writing verse because the captain of a monitor refused to fire his A.A. gun on a Sunday, the only fine day for three weeks. On Christmas Day 1918 he sent me the four volumes of his grandfather's book "Lives of the Engineers", with a note thanking me for my kindness. Everyone else—by then we numbered forty or so—knew who ought to be thanked.

When it was all over, the arithmetic finished and the instruments packed up, Hartree came to me with a long face and said it was a bad business; he had never enjoyed anything so much, now what could be done about it. Having no intention myself but to return, after nearly five years absence, to physiology, and being young enough to believe that I could (it will be harder this time), I said "Why not come and do physiology at Cambridge?" So Hartree was set to read Bayliss' "Principles of General Physiology", and in a few weeks returned and said that he had not known before that physiology was as interesting as that, and he would come; which he did, for fourteen years. We started off in 1919 on the physiology of muscle, its heat-production, its dynamics, its recovery processes and its various peculiarities; and Hartree learned to make and manage thermopiles, levers, galvanometers, oscillators and Ringer's solution; and—what is much harder for an engineer—to dissect the muscles and nerves of frogs, tortoises and hedgehogs and keep them alive and working. The observations required skill and patience, and the records needed a deal of measurement and calculation—so much the better! Hartree was the first to discover what ought to be called the 'Hartree Effect', that of after-exposure in intensifying photographic records.

I left Cambridge in 1920 for Manchester, moving to London in 1923, but Hartree carried on the work in Cambridge until 1933. On the physiology of muscle and allied subjects in that time came ten papers under Hartree's name alone in various journals, twenty-four under his name and others. We kept in continual touch by post and by as frequent visits as I could pay. I found him always either with his apparatus in a dark room, or perched precariously on his chair on the fuse-tins, doing the arithmetic; never absent, however unexpected the visit. He arrived first in the morning, he usually left last at night—for love.

It would not be fitting, in such joint work, for me to assess its value; but such value as others may attribute to it is due in large part to my collaborator—it certainly would not have been done without him. Some record of part of it is given in "Adventures in Biophysics" (1931).

By 1933 physical disability had made it difficult for Hartree to stand for the long hours necessary in the experimental work, and he felt also that the job which he had set his hand to in 1919 was more or less finished. He turned to his son, D. R. Hartree, for a new one. Fortunately, there were plenty of them that could be tackled at home, and of the kind that needed his patience, accuracy and planned methodical style. The main field of this work was in the calculation of atomic structures, but in the course of time he gave most valuable help in other fields, in particular in some exploratory work on a method for the numerical solution of partial differential equations, in the application of this method to the boundary layer equation in the motion of a viscous fluid, and in connexion with the gas flow in

a tube. I gather from his son that his contributions to the practical calculation of atomic structures have been substantial and important. This work is not routine computing; it is essentially a matter of successive approximations, involving making and adjusting a set of estimates until a set of results, derived from these estimates by calculations which may take a week or two, agree with the estimates themselves; it needs understanding and judgment, far beyond that required for routine arithmetic.

The common experience of father and son at Whale Island, in trajectory and similar work, meant that they could talk the same language of methodical calculation, and another happy and fruitful collaboration developed, lasting until Hartree's death. Their joint papers are to be found particularly in *Proc. Roy. Soc. A*, from 1935 to 1939, while papers by Hartree and M. F. Manning are in *Phys. Rev.* 1940 and 1941. As D. R. Hartree wrote me, "I regard his work for Cu as a considerable technical feat; one aspect of it is that it forms the solution of a system of 34 simultaneous non-linear differential equations!"

This work with D. R. Hartree was done with the same "good companionship" (as E. A. Milne, another of the Portsmouth party, called it) as his previous work with others. "My father," D. R. Hartree writes, "once protested that he did not know the basic theory of the atomic work well enough to be cross-examined on that part of the papers, and so did not think that his name should appear on the title-page." Exactly the same diffidence had appeared in his earlier collaboration with others. "He would have been quite content with a formal acknowledgment at the end, and would not have been particular even about that. But his contribution in these papers was really the main one, without which they would not have been, and it would have been grossly unrepresentative of our relative contribution to the work if it had been published in papers under my name alone." As in physiology, so in atomic physics!

Hartree won a cup for fives at school, his handicap at golf came down to four, he was a good hand at tennis and bridge, and his collection of 'postage paid' postmarks is said to be unique in range and completeness. But of such things he never spoke. For many years before 1916 he had worked, no doubt, as methodically and as carefully as he did later; but there is no printed record of the result. It is strange to think that the method of those ballistic calculations and carefully digested records of observations at Whale Island, and the 'good companionship' of the partnership there, could find so far an extrapolation to physiology and atomic physics at the hands of this shy, gentle, kindly man. The greatest discoveries, however, are made by keeping one's eyes open and one's mind alert for the odd things that turn up—in human relationships as well as science. Hartree turned up in 1916, and those who knew and worked with him since then are richer in both.

A. V. HILL.

WE regret to announce the following deaths:

Mr. W. R. Bousfield, K.C., F.R.S., an authority on patent law, on July 16, aged eighty-nine.

Prof. H. L. Demler, formerly professor of physics in the Technische Hochschule, Dresden, later head of the Department of Physics, University of Istanbul, and finally visiting professor in Rutgers University, on March 22, aged sixty.

Dr. Gerard De Geer, the eminent Swedish geologist, aged eighty-four.

Mrs. E. C. V. Mattick, research worker in dairy chemistry in the National Institute for Research in Dairying, Reading, on July 18.

Prof. E. P. Stibbe, University professor of anatomy in King's College, London, on July 23, aged fifty-nine.

Mr. Fred Stoker, the well-known horticulturist and author on gardening topics, on July 20.

NEWS and VIEWS

Prof. R. A. Fisher, F.R.S.

IT has been announced that the chair of genetics in the University of Cambridge is to be filled by the appointment of Prof. R. A. Fisher, who has been Galton professor in the University of London since 1933. Before that time he was head of the Statistics Department at Rothamsted Experimental Station. Prof. Fisher has been actively associated with genetics since 1918 when he showed that the biometrical correlations observed between relatives were to be expected on the Mendelian theory. He has written extensively on the action of selection, and he has shown that the manifestation of any gene must be regarded as modifiable through the action of selection on other genes in the nucleus. This culminated in his well-known theory of the evolution of dominance by selection and in his analysis of the genetical basis of mimicry and natural polymorphism. The mathematical theory of selection in relation to variation and mutation was further developed in "The Genetical Theory of Natural Selection" (1930), which also deals with the genetical aspects of human society. As would be expected, Prof. Fisher has been responsible for many improvements in the statistical analysis of genetical results, especially in the methods of coping with the peculiar difficulties of human data. His early work on the genetical interpretation and statistical analysis of biometrical data has also been extended, notably in a paper published jointly with F. R. Immer and O. Tedin in 1932. This work is perhaps less widely appreciated, largely because geneticists as a body have been shy of attacking the inheritance of quantitative characters; but interest in this subject is reviving, and Prof. Fisher's findings must have their influence on future developments here, as in other fields. It is indeed singularly appropriate that he should both have succeeded Pearson in London and become professor of genetics in the University where Bateson and his associates did so much to extend and amplify Mendel's results, for no one has played a larger part in uniting the once conflicting sciences of biometry and genetics.

University of London: New Principal

MR. HAROLD CLAUGHTON has been appointed principal of the University of London as from August 1, 1943. Mr. Claughton was educated at

Radley and Trinity College, Oxford. During 1906–1911 he was in India in the Imperial Record Department and the Home Department, acting occasionally as examiner in history for the University of Calcutta. He resigned in 1911 and for three years occupied himself with literary work. He volunteered for active service in 1914 but was rejected on account of short sight. In 1915 he was appointed to Military Intelligence, War Office. At the beginning of 1919 he was appointed assistant secretary, and in November 1920 secretary, of the Surplus Government Property Disposals Board. He resigned at the end of October 1923 as the work of the Board was then practically completed. In 1924 he became financial officer and secretary to the Senate of the University of London, which post he held until, in 1929, he was appointed the first clerk of the Court. During September 1939–January 1940 he was private secretary to the Minister of Information (Lord Macmillan). He then resumed his duties as clerk of the Court, acting as deputy to the Principal of the University from June 1940 until he became Acting Principal in October 1941. He was awarded the O.B.E. in 1918 and the C.B.E. in 1923. He is also an Officier d'Académie Française.

Economics of Reconstruction in Britain

THE Oxford Pamphlet on Home Affairs, "Will the War Make Us Poorer?" by M. Young and Sir Henry Bunbury (Oxford University Press. No. H.5.; 6*d*. net), covers some of the ground of the Planning broadsheet "Financial Mysticism" and is a valuable contribution to the lucid thinking required in the appraisal of the Beveridge and other proposals for post-war reconstruction. The authors point out that the only real limits on production are set by the available skill, equipment and organization, and that money for the individual and money for the nation as a whole have very different functions to perform. They also give a warning against the restrictionism that involved us in disasters in 1919 and 1922, as well as against the danger of spending too fast after victory is won. Mr. Young and Sir Henry Bunbury then discuss three typical questions which the ordinary man is asking himself: Where does all the money come from? Do private savings do any good? Shall we be poorer after the War? The clear answers given to these questions lead to the conclusion that a few hard and difficult years may, provided we have vision and courage and seize our opportunities, lead us to a better and more securely based society than for many decades. Good organization will be essential, including good monetary organization, with money not as a controller but as a servant of human affairs. The authors insist that we cannot again afford to waste our resources of men and material; we cannot afford unemployment, or to lose great slices of our potential national income by wasting our resources. They are equally emphatic that the expenditure required to rebuild Britain, to implement the Beveridge Plan, and to raise the standard and quality of living for the people of Britain, can be provided if our great human resources are properly utilized and co-ordinated with the resources of other nations.

Water Requirements of Rabbits and Guinea Pigs

THE prevalent idea that rabbits and guinea pigs do not drink still persists widely in spite of all that has been written, said and broadcast. Prof. E. L. Kennaway directs attention to this false impression in a recent issue of the *British Medical Journal* (1, 760; 1943), where he reports that a 2·5-kilo rabbit on a dry diet will take approximately 160 c.c. of water, or 65 c.c. per kilo, daily, which is approximately twice the intake of an average human adult derived from both food and drink. It appears that rabbits fed mainly on a dry diet suffer from both water and food starvation, which is indicated by poor condition and scanty contents of the gut found post-mortem. If such an animal is provided with water, it takes a long drink and then greedily eats the dry food. It is obvious that water is essential for the normal physiology of the rabbit; the flesh (muscle and fat) of mature rabbits contains approximately 67 per cent moisture (King Wilson and Botham, 1934), being higher in males than females fed on similar diets. In comparative tests in feeding (*a*) dry mash and greenstuff, (*b*) dry mash and water and (*c*) dry mash, greenstuff and water (Christian, 1936) the best growth and development was obtained by (*c*), whereas (*a*) without drinking water caused impaction of the cæcum. Deprivation of water results in loss of appetite and a decline of 20 per cent in fur growth (Wirth, 1936).

Whether or not a rabbit will drink depends upon the moisture content of the diet; for example, a mixture of roots or potatoes and hay provides sufficient moisture (Brüggemann, 1937) for maintenance, whereas cereal grains and meadow hay required approximately 130 c.c. additional drinking water. When fed hay only, they drank about 150 c.c. of water but individual rabbits varied greatly (118–200 c.c.), requiring more in hot weather. Replacement of dry mash by fresh tea leaves in mixed diets resulted in a marked decline in water drinking (King Wilson, 1942). For production requirements the water supply is even more important. Although there is more dry matter in rabbit's than cow's milk, deficiency was seen to cause urine drinking and is one of the causes of cannibalism. Very similar results were observed with guinea pigs on restricted green-food diets.

Bell Laboratories Rubber Research Laboratory

ACCORDING to an article (*Bell. Lab. Rec.*, **21**, No. 8; April 1943) by F. S. Malm, the Bell Laboratories have for many years been actively engaged in research on the chemical and physical properties of rubber and its compounds, to determine the kind of materials required to withstand severe weathering and the constantly changing conditions of temperature, humidity and light exposure. Most of the work has been directed to improving insulating materials made from plantation rubber, but an increasing part has been directed, during recent years, to synthetics such as Buna S and neoprene. Extensive studies have been carried out on insulation for submarine cables leading to the development of Para-gutta and pressure-equalizing materials for loaded telegraph cables. Insulation has been developed for coaxial cables and more recently dielectric materials for ultra-high frequency and micro-wave cables. Rubber jackets were also devised to protect against corrosion in the trans-continental cable being laid between Omaha and Sacramento.

About a year ago the Rubber Group moved to new laboratories at Murray Hill where complete facilities have been provided for studying rubber and its synthetic substitutes and for improving them. In anticipation of a peak load in this work additional equipment was installed including mixers, vulcanizers and apparatus for physical and chemical tests. All

of this rubber-working equipment is provided with auxiliary apparatus for controlling and recording temperatures, pressures and power consumption. The laboratory rooms are unique in that any of fifteen different services including electric power, air pressure, vacuum, hot and cold water, hydrogen, oxygen and nitrogen in addition to illuminating gas are available at any bench or can easily be made so. To improve the desirable characteristics of a rubber material and suppress the undesirable ones the rubber research organization endeavours to relate the physical characteristics of elastic materials to their molecular structure. Special apparatus is used in studying what happens to the rubber molecules when they are compounded, vulcanized, and destroyed through use. These studies on the mechanism of vulcanization, viscosity, molecular weight and brittleness of rubber and allied substances are associated with current synthetic rubber problems.

Photography of Stars in Daylight

MANY years ago it was predicted that stars close to the sun should be visible to an observer using a suitable technique. Only recently, however, has such a technique been developed, primarily for investigating the solar corona without waiting for a total eclipse. News has now reached Great Britain that a Swiss attempt to photograph stars in daylight with the aid of a coronagraph has been successful (M. Waldmeier, *Z. Astrophys.*, **21**, 269; 1942). A photograph obtained at Arosa, at an altitude of 2,050 m. in the Alps, shows Regulus (mag. 1·34) quite clearly at a distance of 12′ (less than the sun's angular radius) from the edge of the solar disk. The observation is possible only by eliminating so far as possible diffracted and diffused light in the apparatus, and by observing at a great altitude to avoid meteorological scattering. The successful photograph was obtained at midday on August 22, 1941, with a 15-sec. exposure through a red filter. Regulus is the only first-magnitude star within 1° of the ecliptic, but there are a number of fainter stars (down to third magnitude) which, it is considered, could be photographed in favourable conditions.

One obvious application of the method is to the measurement of the gravitational deflexion of light. The Einstein effect has been observed at several eclipses since 1919 at considerable expense and with many disappointments, and the results have not been all that could be desired. The coronagraph method, if it can be developed so that precision measurements are possible (at present the objective is an uncorrected single lens, though the field which must be covered is at least 1° in diameter), will have many advantages. Accidental errors could be considerably reduced by multiplication of observations, for example, and the photographs would be taken under favourable working conditions at an established observatory instead of in the somewhat hectic circumstances of a total eclipse.

Health of New Zealand

IN his annual report for 1941–42, Dr. M. H. Watt, the director-general of health of New Zealand, states that during this period cerebrospinal fever has become epidemic on a small scale, as is shown by the fact that in the whole country there were 163 cases with 25 deaths among 1,538,620 Europeans, while there were 47 deaths among about 87,000 Maoris. It was found that the meningococcus was widespread among the employees at a freezing company, which suggested that the effect of the intense cold on the nasal mucous membrane lowered the local resistance so as to allow penetration of the organism. Of recent years there has been a considerable increase in known syphilis throughout New Zealand, the number of cases treated at the clinics being 156, 192, 285 and 403 during the last four years. There has also been a sharp rise in notification of males suffering from tuberculosis, similar to that found in all the Allied countries and attributable to the special methods employed in the examination of recruits. As regards vital statistics, the birth-rate in Europeans was 22·81 and the death-rate 9·81, while in Maoris these rates were 44·77 and 20·59 respectively. The infant mortality of the Maoris was 125·06 as compared with the European rate of 29·74.

Sudden Rise in Birth-Rate in the United States

ACCORDING to an editorial in the January issue of the *Statistical Bulletin*, the organ of the Metropolitan Life Insurance Company of New York, fairly complete data for 1942 for five large cities in the United States, namely, New York, Boston, Baltimore, Washington, D.C., and New Orleans, show not only that the general level of births for 1942 is materially higher but also that the profile of the curve is completely changed. Instead of a spring and a summer maximum there was a strong upward movement of births beginning about September and continuing almost unbroken to the end of the year. Moreover the level for the entire year is far above that of the period 1938–1939. The sudden increase in births in September and October 1942 would seem to be connected with the outbreak of war in December of the previous year.

Recent Earthquakes

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the epicentres of three recent earthquakes. The first occurred on March 7 at 3h. 01·5m. U.T. from an epicentre situated 57° N. lat., 164° E. long. This is in the Pacific Ocean near the east coast of central Kamchatka Peninsula. The second and third were both on March 9, at 3h. 25m. 32s. and 9h. 48m. 37s. U.T. respectively. The first on March 9 was from latitude 42·2° N., longitude 80·9° W., which is in the bed of Lake Erie to the west of Erie (city) and north-north-east of the city of Cleveland, and the second on March 9 from an epicentre at latitude 56° S., longitude 22° W., which is in the south Atlantic east of the island of South Georgia. All interpretations and calculations are tentative.

Announcements

AT the recent annual meeting of the Genetical Society the following officers were elected: *President*, Dr. C. D. Darlington; *Vice-Presidents*, Dr. R. N. Salaman, Prof. T. J. Jenkin, Prof. R. A. Fisher; *Treasurer*, Miss E. R. Saunders; *Secretaries*, Mr. E. B. Ford, University Museum, Oxford; Mr. W. J. C. Lawrence, John Innes Horticultural Institution, Merton, S.W.19.

ERRATUM.—In the News and Views "Announcements" in NATURE of July 10, we regret that we announced Dr. R. R. Mimms as being appointed lecturer in physics in the University of Birmingham. This is incorrect; for Dr. R. R. Mimms read Dr. R. R. Nimmo.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Research and Ships' Antifouling Paints

A SUB-COMMITTEE of the Iron and Steel Institute recently produced the first report of the Marine Corrosion Sub-Committee. This was anticipated by the presentation of two papers dealing with the same subject. One was by Dr. G. D. Bengough and Mr. V. G. Shepheard in London, at the Institute of Naval Architects, on April 15, 1943, and the following day a very similar paper by Dr. Bengough in Newcastle-upon-Tyne at the North East Coast Institution of Engineers and Shipbuilders. These papers dealt with the work of the sub-committee carried out by the official investigator, Dr. J. C. Hudson, under the chairmanship of Dr. Bengough.

It is not proposed here to criticize technically the points of difference which research workers in the industry have with the findings of the Committee, as this has been dealt with fully in written communications to the societies at which the papers were presented. What I wish to set forth here is that the whole attitude of this new sub-committee, and the reasons for its being created, seem to have been based on the assumption that no serious research work had been done on this subject; this is very far from being true.

The suggestion underlying both the papers and the report is that manufacturers have no idea how their products function, and shipowners do not receive compositions best suited to their purpose. This is quite contrary to fact, as indeed many members of the antifouling paint industry have carried out intensive research over many years, but, of course, have not published their results, as these would be of benefit to competing firms both in Great Britain and abroad. In the early days of the industry, researches were mainly by trial and error, but it must not be overlooked that these methods resulted in quite good antifouling paints. About twenty-five years ago, to my knowledge, this method of approach had reached its limitations, and research work on strictly scientific lines by scientific men appointed for this purpose, and in no way responsible for production, was instituted. This necessitated fundamental biological work into the life-histories, methods of attachment, and reactions of marine organisms to poisonous and non-poisonous surfaces. Alongside the biological work, research in the laboratory for new and better toxins had been continuous. One new toxin, fully tried and proved, has been used in antifoulings now for twelve years or more.

In view of the above facts, it is surprising that public money and effort by scientific men is used in an endeavour to undertake work which has already been done. No one will question the importance of preventing fouling, and so maintaining maximum speed, or conversely minimum fuel consumption, in peaceful times; and under war conditions it assumes a vastly greater importance. Nevertheless, the fact does remain that the industry is capable of supplying compositions which provide longer periods of immunity from fouling than those in general use, or even those used by the Admiralty, so the work of the Committee is redundant. There are, no doubt, reasons which influence shipowners not to choose the most efficient available paint, and they are presumably satisfied with what they use, which shows, at any rate, that the industry is ahead of shipping requirements, entirely due to the composition manufacturers' scientific research. It shows also that the work on antifoulings as so far carried out by the Marine Corrosion Sub-Committee is quite unnecessary; on the other hand, research of a purely academic character would be welcomed by scientific workers in the industry.

Although research work by the industry had not been published, nevertheless before the formation of this Sub-Committee, Dr. Hudson, the official investigator, was commissioned by the Admiralty to carry out investigation on existing commercial brands of antifouling compositions, and some six gentlemen, including Dr. Bengough, the chairman, and Dr. Hudson, visited the marine biological testing station of the research department of my Company, where much of the work was gone into in detail. It was assumed that this work for the Admiralty would be confidential, and there was no hesitation on our part in revealing details of that research work. That the Sub-Committee in its report makes no mention of this, and that the greater portion of the report is derogatory to the research done by the industry, is, to say the least of it, somewhat surprising.

There is one final point that I would like to mention—namely, that this industry is primarily British. Those manufacturers of antifouling compositions in foreign countries are, almost without exception, offshoots of some British parent company. The avowed intention of the Marine Corrosion Sub-Committee is to publish details of formulation and manufacture of antifouling compositions which will ultimately, of course, be available to anyone in the world. The effect on British export of such an action as they contemplate is self-evident, and does not need emphasizing.

P. EWART BOWLES.
(Director of Research.)

The International Paint and
Compositions Co., Ltd.,
Grosvenor Gardens House,
London, S.W.1.

REFERRING to the above letter by Dr. Bowles, I should like to make the following comments.

No statement or assumption has been made by the Marine Corrosion Sub-Committee "that no serious research work had been done on this subject". The Sub-Committee has no detailed knowledge of the amount of work done, the technique or the conclusions achieved by Dr. Bowles and his colleagues, because their researches have not been published and are not accessible to the Sub-Committee, and, therefore, no references can be made to the work. The Sub-Committee believes that, however much has been done, still more is required, partly because the fouling of both naval and merchant vessels is still a serious matter, and partly because of the wide variation in performance of compositions at present on the market made by different manufacturers, and the lack of unprejudiced guidance about their relative values in the different types of conditions to be met on the world's shipping routes.

In support of the first of these statements, I may point out that the Admiralty authorities calculate from their own practical experience[1] that 20 per cent of the total fuel burnt on warships is used in overcoming the retardation set up by fouling organisms;

for the merchant navy it is only necessary to pay a few visits to shipping home in dry-dock from certain world-routes to see that the problem of fouling has not, so far, been solved.

The statement that the anti-fouling composition industry "is capable of supplying compositions which provide longer periods of immunity from fouling than those in general use, or even those used by the Admiralty", but that shipowners do not choose to use them, suggests that the industry has failed to bring its products adequately to the notice of the Admiralty and shipowners, or that these bodies do not take the same favourable view of these products as do the makers, or that the prices charged are not reasonable. Inquiries among merchant shipping companies, particularly those trading to tropical ports, show that improved anti-fouling compositions would receive a ready welcome, provided that they enabled ships to make an additional voyage without docking, and particularly if the paints could be bought to specification and could be produced free of that expensive and scarce ingredient mercury.

The Sub-Committee's work is not a specifically war-time measure; for a country such as Great Britain, which will always be dependent on water-borne transport to bring many of its supplies, and which will still maintain a fleet, the production of the best possible anti-corrosion and anti-fouling paints will always be an important matter. This problem should, therefore, be considered from the point of view of the national interest. In his last paragraph, Dr. Bowles suggests that any successful work achieved by the Sub-Committee would interfere with the export trade of the anti-fouling composition industry, which had almost a monopoly of the export trade in pre-war days. Dr. Bowles should be aware of the immense amount of research work, both in the laboratory and on ships, which is now being done in the United States, which possesses a larger official investigating organization than that of this Sub-Committee. Much work is also being done in Japan, and, presumably, in Germany. All these countries will compete for the export trade in the post-war world, and it is certain that the United States will be in a position to produce paints of first-class quality. In Britain there is no Ships Compositions Research Organisation within which the different firms exchange and develop ideas; each separate firm carries on its own work secretly and must attempt to defend its own position individually. Similar attempts have been made by other firms in other industries, and the result has always been the same—the policy of secrecy has had to be abandoned.

The Sub-Committee is, and always has been, ready to co-operate with the anti-fouling composition industry as a whole on the basis of the free exchange of information; it invited about twenty-five firms to send representatives to a meeting, held at Cambridge in January of this year, at which many university scientific men were present; the Sub-Committee outlined its views on many topics and definitely invited co-operation, but so far no response has been received.

As regards the last paragraph but one of Dr. Bowles' letter, the facts are as follows: On December 7, 1939, a meeting of the Admiralty Corrosion Committee was held at Devonport. The chairman, official investigator and one other member of the Marine Corrosion Sub-Committee attended this meeting by invitation, and on the following day accompanied the Admiralty representatives on a visit to the Biological Research Station at Newton Ferrars, by kind invitation of Dr. Bowles' Company, to whom the Station belonged. Dr. Bowles now says that much of the work being carried on was gone into in detail and that this work was regarded as confidential; in the next sentence he complains that no mention of it is made in the Committee's report. My own recollection of the matter, three and a half years after the event, is that most of the time was taken up with a visit to the rafts anchored in the estuary for the purpose of testing paints, and an inspection of some of those paints after they had been lifted from the water. No disclosure was made as to the formulation of the paints, and no advantage was taken by the Sub-Committee of any details divulged about the rafts themselves, as decisions had already been taken about the arrangements of the Sub-Committee's own rafts. It is a little difficult to see what information Dr. Bowles expected the report to contain about this visit, which took place more than three years before its publication.

G. D. BENGOUGH.
(Chairman, Marine Corrosion Sub-Committee.)

Iron and Steel Institute,
4 Grosvenor Gardens,
London, S.W.1.

[1] "The Corrosion and Fouling of Ships", *J. Inst. Naval Arch.* (April 1943).

Stripe Smut of Rye

AN increasing number of farmers now make a routine practice of dressing seed corn before sowing with a reliable organo-mercury seed dressing, for by this means the following diseases are prevented: bunt of wheat (*Tilletia caries*), covered smut of barley (*Ustilago Hordei*), leaf stripe of barley (*Helminthosporium gramineum*), net blotch of barley (*Helminthosporium teres*), covered smut of oats (*Ustilago Kolleri*), loose smut of oats (*Ustilago Avenæ*), and leaf spot (or stripe) of oats (*Helminthosporium Avenæ*).

Although wheat, barley and oats are so treated, the majority of farmers do not appreciate the importance of using a similar dressing for their rye seed, and the manufacturers of these dressings, although they recommend such a treatment, do not always specify a valid reason for its use.

It is of interest, therefore, to record that in Norfolk we have recently encountered cases of stripe smut of rye (*Urocystis occulta*), and on one farm some eighty acres were moderately affected. The disease is rare in Great Britain, for in the past twenty years the senior writer has not observed it in East Anglia, but there is a record of its appearance at Rothamsted in 1932, and Mr. W. C. Moore informs us that a small amount was found near Romsey, Hants, in May 1920, and at Askham Bryan, Yorks, in August 1936, on the rachis of one head in experimental plots. The disease is seed-borne and is known to be amenable to the same treatment as for bunt in wheat; it can, however, be contracted from the soil. As the acreage now under rye has increased, it is suggested that plant pathologists would be well advised to advocate the treatment of rye seed before sowing as a preventive measure against this (and other) diseases and, where cases are encountered, to dissuade a farmer from taking another rye crop in succession on

the same field. We are indebted to Mr. R. Line for first bringing this disease to their notice.

W. A. R. DILLON WESTON.
R. ERIC TAYLOR.

School of Agriculture,
Cambridge.
July 13.

Sharp Eyespot of Wheat caused by *Corticium* (*Rhizoctonia*) *Solani*

EYESPOT of wheat caused by *Cercosporella herpotrichoides* is widespread in East Anglia, where it causes considerable loss in yield[1]. Typical symptoms of the disease are oval brown-bordered lesions on the straws near soil level. Similar, but less regular, lesions caused by another fungus have been recognised at Rothamsted as a different disease since 1935. This was described in Holland and figured by Oort[2], who called it sharp eyespot but did not identify the causal organism. Sprague[3,4] found a Rhizoctonia causing similar symptoms on wheat in Oregon. Blair[5], working with *Rhizoctonia Solani*, found that some Canadian strains when inoculated into wheat caused a stem girdling injury the photographs of which resemble those of sharp eyespot. Neither worker identified the lesions caused by Rhizoctonia as the sharp eyespot described by Oort.

We have obtained wheat plants with sharp eyespot resembling those figured by Oort, Sprague and Blair from many localities in England and Wales, and have consistently isolated from them a fungus of the Rhizoctonia type. We have inoculated wheat seedlings with six isolates from four districts; all produced sharp eyespot lesions, from which we reisolated the fungus. The six isolates have now been identified by Dr. Bisby, Imperial Bureau of Mycology, as strains of *Corticium* (*Rhizoctonia*) *Solani*.

The symptoms of sharp eyespot are rather like those of true eyespot, and care must be taken to distinguish between them. Sharp eyespot lesions tend to be more superficial than those of eyespot and are sometimes confined to the outer sheaths, though they may penetrate the straw; they often run up the stem to a height of several inches. Sharp eyespot has asymmetric lesions with sharply defined borders surrounding pale areas on which develop spreading patches of mycelium. This is at first light-coloured but later darkens to brown or purple. True eyespot differs in having regular oval lesions, generally within two inches of soil level; they have less sharply defined borders, with black spots of mycelium concentrated in the middle of the lesions.

Although sharp eyespot has been found in many wheat fields in England and Wales and one heavily infected crop has been reported, it is seldom present in more than about 1 per cent of the straws. It does not increase with the frequency of wheat or barley in the rotations as does eyespot, which may infect as many as 80–90 per cent of the straws where wheat and barley have been grown often. In the first wheat crop after grass, eyespot is generally absent or rare, but sharp eyespot is found just as commonly as on old arable land.

MARY D. GLYNNE.
WENDY M. RITCHIE.

Rothamsted Experimental Station,
Harpenden, Herts. July 13.

[1] Glynne, Mary D., *Ann. Appl. Biol.*, **29**, 254 (1942).
[2] Oort, A. J. P., *Tijdsch. over Plantenziekten.*, **42**, 179 (1936).
[3] Sprague, R., *Phytopath.*, **24**, 946 (1934).
[4] Sprague, R., *Phytopath.*, **27**, 798 (1937).
[5] Blair, I. D., *Canad. J. Res.*, C, **20**, 174 (1942).

Petal-Colour Inheritance in Lychnis

INVESTIGATIONS of petal-colour inheritance in Lychnis species have resulted in considerable confusion owing to insufficiently precise identification of the forms studied.

Numerous authors, from Bartram[1] (1699–1777) to Winge[2], have found the production of petal-anthocyanin to be dominant in crosses between the closely related *L. alba* Mill. (*L. vespertina* Sibth.), with white petals, and *L. dioica* L. em Mill., with reddish-purple petals (Shull reunites both under the latter name). By crossings in reciprocal directions I have fully confirmed this. In a back-cross between the F_1 and *L. alba*, segregation took place in the ratio of one plant with coloured petals to one with white petals.

Only Shull[3] differs from this belief, postulating that the production of colour depends upon the action of two dominant genes, each of which can be carried latent in white-petalled individuals. No other author has confirmed this and so far as I am aware Shull has not repeated it.

The existence in Nature of individuals resembling *L. alba* but possessing coloured petals (*L. alba* var. *colorata* Lange) might be advanced as support for Shull's theory, but several authors have noticed that these individuals are absent from areas from which *L. dioica* is also absent. Post[4] does not mention them from Palestine and Sinaii, where *L. dioica* does not occur. I have investigated many individuals of this kind (in several cases in swarms) and circumstantial evidence from the localities, together with positive evidence from pollen-sterility counts, measurement of certain vegetative and floral parts and comparison with hybrids (raised in the experimental plot from artificial crosses) as well as herbarium material has convinced me that they are either hybrids between *L. alba* and *L. dioica* or descendants therefrom.

In both *L. alba* and *L. dioica* the production of anthocyanin in the vegetative epidermis and the calyx (especially of staminate plants) is marked. Experiment has shown that it may be caused to develop even further by increased insolation, waterlogging of the soil, etc. Such increase is reflected in greater depth of petal coloration in *L. dioica* as the plants are transferred from shade to full exposure and vice-versa.

Although the petal-colour of the F_1 hybrid is less intense than that of *L. dioica* when the progeny is grown under the same conditions as the parent, variation of these may upset its manifestation. The matter is further complicated by the accompaniment of anthoxanthin, which certainly acts as a co-pigment to the anthocyanin, causing a bluing of the reddish-purple colour of *L. dioica*. It is present to a greater extent in *L. alba* than *L. dioica*, as might be expected on the basis of Lawrence and Scott-Moncrieff's[5] theory of the common precursor and balance of anthocyanin and anthoxanthin. These factors are probably partly responsible for the great range of colour shown by F_2 generations.

After frost or rain and as the season progresses, the shade of the coloured petals becomes increasingly blue. These facts probably dispose of Shull's factors for "reddish-purple" and "bluish-purple".

A variety of *L. dioica* is known (*L.d.* var. *albiflora* Tin.) with white petals. Examination of this form from several sources, combined with herbarium investigations at the Royal Botanic Gardens (Kew), the University of Cambridge, the British Museum

(Natural History) and the South London Botanical Institute (to the authorities of which I am very grateful) have shown that this variety contains no anthocyanin anywhere in the plant under normal conditions. My measurements show that the specimens are not hybrid segregates with white petals, although they have occurred in widely separated localities where natural hybridization has been present.[8] It is possible that this process has been a stimulus to mutation.

A cross has been made by pollinating this form with pollen from normal *L. dioica*, which gave equal numbers of plants with anthocyanin in both vegetative portions and petals and plants containing no anthocyanin whatever. This may be explained by the assumption that inhibition of anthocyanin production is due to the action of a dominant gene, and that the white-petalled parent was heterozygous in this respect (as would be expected in a plant from Nature). The inhibition causes the production of white petals, even though the plant may carry the gene which produces petal colour, in the absence of the dominant modifying gene. The inhibition is not quite complete, for the partially unfolded petals have a faint salmon-pink colour, which reappears as the petals fade. When fully open the petals have a tantalizing "near-pinkness". The petals of *L. alba* often develop colour on fading, but this is blotchy and bluish.

The growth of a plant of the var. *albiflora* in artificially water-logged soil in full insolation has shown that anthocyanin is produced in the stem, but in very much less quantity than in normal *L. dioica* under similar conditions. Modification of inhibition is probably the cause of the pink petals developed by Harrison's[9] white-petalled variety after infestation with *Contarinia steinii*.

The presence of an analogous form in *L. alba* might be expected, and it is believed that it has been found in a group of four individuals found among many thousands of specimens growing in a field going fallow at Varndean, Brighton. That four individuals should occur so close together in a position where it is unlikely that more than two generations were present makes it probable that the inhibiting action is again due to a dominant gene. Flowers of this variety of *L. alba* do not show any blotches of colour when they fade.

The inhibition of anthocyanin production does not inhibit the production of anthoxanthin, the varieties described giving anthoxanthin reactions in approximately the same strength as *L. dioica* and *L. alba* respectively.

Lychnis coronaria normally possesses anthocyanin in both stem and petals, but a recessive white-petalled variety exists in cultivation which has anthocyanin in the stem in comparable quantity. This case is analogous with that of *L. alba*.

Further extensive pollinations have been performed, and with the results from these it is proposed to deal with the matter in detail elsewhere.

114 Evelyn Crescent, Sunbury-on-Thames, Middlesex.
June 20.

H. G. BAKER.

[1] Bartram, J. in Zirkle, C., "The Beginnings of Plant Hybridization", 148 (Philadelphia, 1935).
[2] Winge, Ö., *Hereditas*, **9**, 274 (1927).
[3] Shull, G. H., *Bot. Gaz.*, **54**, 120 (1912).
[4] Post, G. E., "The Flora of Palestine and Sinai", vol. 1 (Oxford, 1932).
[5] Lawrence, W. J. C., and Scott-Moncrieff, R., *J. Genet.*, **30**, 155 (1935).
[6] Harrison, J. W. H., *Entom. Month. Mag.*, **78**, 231 (1942).

A Suggestion respecting the Bacteriostatic Metabolic Products of Moulds

IN view of the variability of many fungi and the possibility that moulds and bacteria may be mutually biologically antagonistic when growing in the same medium, it is perhaps not too fanciful to suppose that repeated culture of a mould and pathogenic bacteria together may develop increased production of bacteriostatic metabolic products of the former. Various forms of the assumed antagonism can be imagined, and competition for a common growth-factor is probably the simplest. Furthermore, provided such antagonism exists, it is easy to see that in still or viscous media the mycelial nuclei that contained cells producing the bacteriostatic substance would have the greater survival value.

I have no present opportunity to test this idea myself, but think it would be worth while to try to produce bacteriostatic substances against selected pathogens by repeated mixed cultures, using a variety of moulds for the purpose.

R. ROBINSON.

Dyson Perrins Laboratory,
Oxford.
July 17.

Sex Ratio Affected by Host Plant

THE cacao thrips *Selenothrips rubrocinctus* (Giard) is an important pest of cacao (*Theobroma cacao*) in the West Indies, West Africa and Brazil, and also attacks a number of other tropical plants, including mango, avocado, guava and cashew. It is a parthenogenetic species, although males occur rarely in the field. The males are very active and frequent copulation occurs, the sexes remaining *in copula* for from one to three minutes.

Urich[1] in Trinidad was the first to make observations on the male. Reyne[2] in Surinam found that the generation produced by mated females differed in no way from the normal parthenogenetic generation. Mating is apparently unsuccessful, and I have similarly been unable to obtain a sexual generation. I agree with Reyne's suggestion that the occurrence of males is apparently no longer of any importance to the species and is probably only a remnant of the former method of sexual reproduction. Reyne (*loc. cit.*) made counts in Surinam of 77 males and 29,100 females on cacao, the sex ratio being 1 male : 378 females and the percentage of males 0·26.

Large numbers of cacao thrips are required for experimental work in Trinidad, and they can be more readily obtained from cashew (*Anacardium occidentale*) than from cacao. The species of thrips occurring on cashew is undoubtedly the same as that found on cacao, but larger populations are as a rule encountered on the former host plant.

It was frequently observed in the field that male cacao thrips were more numerous on cashew than on cacao. Counts made in Trinidad in 1941 and 1942 gave the following results: on cacao 14 males and 9,728 females, the sex ratio being 1 male : 695 females and the percentage of males 0·14; on cashew 80 males and 3,440 females, the sex ratio being 1 male :

43 females and the percentage of males 2·33. Males were therefore more than sixteen times as numerous on cashew as on cacao.

The following, among other suggestions, might be put forward to explain these facts: (1) the production of a greater proportion of males with higher population densities; (2) the differential mortality of the sexes on the two host plants; (3) the physiological effect of the food; (4) the existence of distinct biological races on the two host plants; and (5) cashew, being supposedly more nearly allied to the original host plant than is cacao, supports a population more closely akin to the bisexual gamogenetic form hypothetically present on the ruderal host plant.

The significance of this phenomenon is unknown and no explanation is advanced. It would be interesting to know of any other examples among insects of the sex ratio being similarly affected by the host plant.

E. McC. CALLAN.

Entomology Department,
Imperial College of Tropical Agriculture,
Trinidad, B.W.I.

[1] Urich, F. W., Circ. Board Agric., Trinidad, 6–7 (1911).
[2] Beyne, A., Bull. 44, Dept. Landb., Surinam, 50–52 (1921).

Reductone and Vitamin C

DR. F. WOKES and his colleagues have referred[1] to the chemical similarity of the reductones to vitamin C. The production of reductones by heating carbohydrates with alkali[2] is incorrectly attributed by them to Norrish and Griffiths, but it may be mentioned that the latter[3] obtained a high yield of reductone (hydroxypyruvic aldehyde) by irradiating glyoxal vapour with violet and near ultra-violet light.

Hydroxypyruvic aldehyde, a substance chemically akin to vitamin C and the carbohydrates, can be produced from inorganic sources by the following sequence of reactions:

$$(1)\ O_2 \xrightarrow[\text{light}]{\text{U.V.}} O_3;\ (2)\ O_3 + C_2H_2 + H_2O \rightarrow C_2H_2O_2 + HCO_2H;^4$$

$$(3)\ C_2H_2O_2 \xrightarrow[\text{light}]{\text{U.V.}} CO + CH_2OH.CO.CHO.$$

Such a short series of formally simple reactions may suggest the possibility that traces of reductone might be formed from the gases in the atmosphere without the intervention of a living organism, but this appears highly speculative.

J. G. A. GRIFFITHS.

London, N.14.
July 13.

[1] Wokes *et al.*, NATURE, **152**, 14 (1943).
[2] Dr. Wokes has kindly informed me that the reference should be to Euler and Martius, *Annalen*, **505**, 73 (1933).
[3] Norrish and Griffiths, *J. Chem. Soc.*, 2829 (1928).
[4] Wohl and Bräunig, *Chem. Z.*, **44**, 157 (1920).

Conception of the Tail in the Craniata

THE word 'tail' is used in the anatomy of the Craniata indiscriminately for two concepts: first, for the post-anal appendage, and secondly (especially in osteology) for the post-sacral region. While directing research on the anatomy of the Testudinata and other reptiles for many years past, I have often been struck by the unjustifiability and ambiguity of this usage and the confusion that results from it. Although in many vertebrates the two regions commonly denoted by the term 'tail' may appear to be more or less co-extensive, careful observation reveals that they scarcely ever correspond with each other to such an extent as to be regarded as identical. The anus seldom if ever lies precisely at the hinder level of the sacrum. In some cases (testudinates, crocodilians, etc.) it is a longitudinal slit and may extend beyond the limits of a single vertebral segment, its anterior rim usually lying distinctly posterior to the hind face of the sacral (or the last sacral) vertebra.

In the testudinates, perhaps, the condition is the most remarkable. While the sacro-iliac articulation lies craniad to the posterior border of the carapace considerably within the corselet, the anus occupies a position always outside the shell when the 'tail' is fully extended. Such a position of the anus, markedly posterior to the hind face of the sacrum, is apparently correlated with the functional necessity of discharging the fæces beyond the corselet margin. Thus the two regions commonly connoted by the word 'tail' are here very distinct, as the intermediate region between the sacro-iliac articulation and the anus is fully developed. The post-sacral part is always present although the post-anal region may be more or less atrophied in certain cases.

In view of this disparity in meaning, it may be best to restrict the word 'tail' uniformly to one concept, the post-anal appendage, and apply another word to the post-sacral region. For the latter a suitable term is already available, the 'coccyx' or 'coccygeal region', but its connotation has to be extended from the post-sacral region of the vertebral column to that of the body and it has to be scrupulously adopted to the exclusion of the word 'tail' whenever this region is meant. Thus the so-called 'caudal' vertebræ should be called the coccygeal vertebræ, the 'urostyle' (Gk. *oura*, tail; *stylos*, pillar) the os coccyx, and the loosely designated 'tail' of testudinates the coccyx or coccygeal region. The part of the coccyx between the sacrum and the anus, which is well developed in turtles, may be called the preano-coccyx in order to distinguish it from the post-anal part of the coccygeal region (postano-coccyx), which is equivalent to the tail, *sensu strictu*.

If we accept this nomenclature, the cyclostomes and fishes have a tail, but no coccyx differentiated at all, as the sacro-iliac articulation is lacking. In other words, they form a division of the Craniata which may be called Acoccygea. The coccyx is distinguished only when the sacro-iliac articulation makes its appearance, and this happens in the Tetrapoda, which may, therefore, be designated Coccygeata.

Among the Coccygeata, the amphibians and reptiles, as a rule, have the tail and the coccyx well differentiated, more or less corresponding with each other but never co-extensive. The difference in position between the anus and the sacro-iliac articulation, which is responsible for the variation in

extent of these regions, is explicable on the basis of functional requirements, since the position of the vent always corresponds to the place behind the sacrum where the muscular movements connected with the pelvic musculature on one hand, and the caudal on the other, bound an area of little myogenic disturbance. This is essential, as otherwise the violent movements of the adjacent muscles might disturb proper defæcation.

In snakes the sacrum has been secondarily lost and thus the coccygeal region is not distinguished from the preceding part, although the tail is well defined.

In the Testudinata, the preano-coccyx contains an extension of the colom around the terminal part of the gut, a feature which is always absent in the tail, strictly defined.

Extant birds have a small coccygeal prolongation but no true tail, although some extinct forms (Archæopteryx, for example) had a fairly long tail. Mammals have both.

Developmentally, the vent, as is well known, marks the position of the blastopore, so that a true tail is strictly post-blastoporal in origin.

BENI CHARAN MAHENDRA.

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March 3.

Arapesh Maternity

THE Arapesh are a people of an area of north-western New Guinea lying at and about 143° 30′ E., and 3° 30′ S. They have a custom of segregating women in outshelters at all times of the catamenia. Like most other women in this respect, Arapesh women do not ovulate or menstruate for an interval after parturition and during nursing. This organic quiescent period is usually known as the lactogenic interval. The Arapesh have the unusual custom that a woman and her husband must notice the advent of the first post-partum onset of menstruation in her body by giving a feast to the neighbours. The first post-partum onset of menstruation in a woman's body during lactation is termed in the Arapesh tongue *helib*. The feast given by a woman and her husband to the neighbours a few days after *helib* is termed in Arapesh *Kwa di batauin*. It takes place, on Arapesh evidence, between six to twenty-five months after child-births, as noted by the nursling having first cut its first two incisors (6–9 months) in some cases, and having first cut all its milk teeth (24 months) in other cases, with a modal time about the intermediate age of the nursling walking and talking.

There are said to be no Arapesh women who resume menstruation during nursing before the infant has cut its first incisors, although the clinical evidence indicates that some Caucasian women resume menstruation during nursing as early as one month after the birth of the child[1]. The Arapesh are an inbred group not more than eight thousand in number, and they may all be representative of a constitutional type with a comparatively long lactogenic interval. However, there is no known explanation of this point of difference. There are said to be some Arapesh women who do not resume menstruation during nursing until the infant has first cut all its milk teeth. The clinical evidence does not indicate that any Caucasian women have as long a lactogenic interval as this. However, the maximal time of the interval, stated to be not long over twenty-four months in the Arapesh population, is possibly not matched in the data available on the Caucasian population, because Caucasian populations usually wean infants before that time, and because early weaning may bring a lactogenic interval not already closed to a close. It may be noted that nursing for three years, which is common Arapesh practice, does not prolong a lactogenic interval for three years.

An assumption in respect to the conditions of a particular type of co-ordination of vital processes is not in the same field as a proof of the action of isolates or of near isolates in vital activities. The assumption that instances of a twenty-four months long lactogenic interval depend upon nursing being continued at least as long, and upon an individual constitutional factor, is not, for example, in the same field as a proof that a certain fraction, not isolated, obtained from the pituitary gland can initiate mammary secretion, and, in some species, stop ovulation[2]. Nevertheless, the assumption is reasonable.

The observation that nursing for three years will not prolong a lactogenic interval for three years is good against the chance, however remote or however proximate it may be, that prior resumption of sex relations after parturition may be an interfering factor provocative of renewed ovulation. The Arapesh do not resume familial sex relations after parturition until after *helib*.

The idea behind the Arapesh practices discussed here is evidently an idea of controlling population growth by abstinence during the lactogenic interval, adjusted to the exact length of time of the interval in individual cases. In previous accounts of Arapesh sociology[3] the idea in point has been distorted and the associated practices incorrectly described. The social 'culture' has been described as "working, selecting a maternal type as desirable, and embodying this choice in every thread of the social fabric"[4]. The Arapesh have, in fact, a predilection for maternal types. They believe, not without prejudice to some, that the constitutional types with the longest lactogenic interval make the best mothers. Nevertheless in matters of history and of social 'culture' the Arapesh still embody ideas in their social fabric. They do not attempt the impossible task, attributed to them, of embodying one constitutional type rather than another, instead of ideas there.

In an account of the associated practices the ceremonial feast at *helib*, namely, *Kwa di batauin*, has been omitted, and the resumption of familial sex relations after parturition has been dated about the time of the nursling walking and talking, without reference to the point that it occurs, in fact, at various times, but always a few days after *helib*.

R. F. FORTUNE.

University of Toronto.
May 25.

[1] Hoskins, R. G., "Endocrinology", p. 294 (W. W. Norton and Co., 1941).

[2] Riddle, Oscar, "Prolactin, a Product of the Anterior Pituitary and the Part it Plays in Vital Processes", Carnegie Institution of Washington, Supplementary Publications, No. 40 (1938). Cameron, A. T., "Recent Advances in Endocrinology" (London: J. and A. Churchill, Ltd., 1940), pp. 388–91.

[3] Mead, Margaret, "Sex and Temperament in Three Primitive Societies" (London: Routledge, 1935). "The Mountain Arapesh", Anthropological Papers of the American Museum of Natural History, 37, Pt. 3 (1940).

[4] Fortes, M., "Review of Sex and Temperament in Three Primitive Societies in Man", pp. 125–26 (July 1936).

AGRICULTURAL EDUCATION ASSOCIATION

SUMMER CONFERENCE

AT the summer conference of the Agricultural Education Association held at the University of Reading on July 8 and 9, the chief topic for discussion was the Report of the Luxmoore Committee on Post-War Agricultural Education. Lord Justice Luxmoore himself was to have been the guest of honour at the conference dinner on Thursday evening, but was prevented from attending by ill-health. Mr. W. J. Cumber, who proposed the toast of the Agricultural Education Association in Lord Justice Luxmoore's place, said that science has yet a lot to teach the agriculturalist, and he himself, in going to the institutes, colleges and universities with the Committee, had learned a great many things which were going to be of advantage to him. He believed in mixing up science with practice, for in that way only would it be possible for British agriculture to compete with the rest of the world.

Three sessions were devoted to discussing the Luxmoore Report, and to facilitate the deliberations a memorandum had been circulated to members asking specific questions. The first question, for example, was: Does the Association agree that *compulsory* continuation classes should be under the Board of Education? With practically no discussion, members agreed.

The second point was, Should the national authority for voluntary agricultural education be a New National Council; the Ministry of Agriculture with appropriate technical staff; or the Board of Education? There was some difference of opinion on these alternatives, though the last authority did not find a supporter. Regret was expressed that the Committee, in considering the re-organization of agricultural education, had not studied the system operating for many years in the United States. Some members thought that the relationship between the Minister of Agriculture and the proposed new national council had not been made sufficiently clear, while others feared that the report envisaged a system of autocratic, centrally-governed education. Others, however, felt that under the proposed central council some of the financial difficulties of the poorer counties might be solved, while at the same time the agricultural education service as a whole would be given a professional status. Eventually it was unanimously agreed that it should be the statutory duty of a competent central body to ensure that adequate agricultural education is provided throughout Great Britain; by a five to one majority, the proposed new National Council was approved as the national authority for voluntary agricultural education.

There was an interesting debate about the desirability of local advisory committees having executive powers, the general feeling being that it would not be possible to get together or hold together the best men on committees that are purely advisory. The desirability of each county initiating the scheme of education best suited to it, rather than having a central scheme forced upon it, was also stressed, and the meeting passed a resolution that the National Council should work through new committees with executive powers to initiate and carry out approved schemes of agricultural education.

With regard to the specialist advisory service, it was suggested that certain of the science subjects, such as mycology and entomology, are not of sufficient economic importance to justify specialist advisers, and that there should be provision for advisory officers in the broader subjects such as botany, grassland, animal husbandry and plant husbandry. American experience was quoted on this matter, and after further debate it was agreed that the present classification by sciences is unsatisfactory and inadequate, and that attention be directed to the need for re-grouping in order to cover the whole field of agriculture.

The conference was unanimous in deploring the proposed separation of the teaching and advisory services, which would seriously impair the efficiency and usefulness of both, and it did not agree with the drastic reduction in the number of provinces recommended in the Luxmoore Report. It also concluded that the unification of the advisory work of the county organizer and that of the specialist provincial advisers would not be easily secured under a provincial administrator, and it re-affirmed the principle laid down in the evidence submitted by the Association to the Luxmoore Committee, namely, that "it is the opinion of the Association that for the efficiency of advisory work all local organizers and specialist advisory officers should be members of one organisation, but this opinion is expressed without prejudice to the opinions held by members about the best administrative means of effecting such unification".

The conference then proceeded to discuss in detail the proposals of the Luxmoore Committee regarding farm institutes, agricultural colleges and university departments of agriculture, taking the paragraphs as set out in the Report. Many of these paragraphs were accepted without debate, but on others there was a useful exchange of opinions which considerations of space make it impossible to report adequately. A fuller account will appear in the Association's journal *Agricultural Progress*. It is interesting to note, however, that there was general condemnation of the national diploma in agriculture.

During the three sessions, the conference was very greatly helped by the contributions of Mr. R. Ede, secretary of the Luxmoore Committee, whose explanations and general assistance were much appreciated by members of the Association.

Turning now to the formal papers, there were two of outstanding educational interest. The first was a description of the progress of grassland research in the United States by Prof. D. B. Johnstone-Wallace, who has returned to Great Britain on special leave after fourteen years as agrostologist and professor at Cornell University. Grassland research in the United States is a comparatively recent development; Prof. Johnstone-Wallace found that there was very little work being done on pasture improvement when he made his first tours in the eastern States during 1929 and 1930. Since then, the importance of phosphorus and nitrogen have been recognized, and the high value of wild white clover has been amply demonstrated. Detailed examination of strains of herbage plants from all parts of the world have been carried out, and it has been found that Kentucky blue grass (*Poa pratensis*), creeping red fescue, and certain types of timothy and cocksfoot, together with wild white clover, are the most useful species for general use. Much is expected from bird's foot trefoil, which has been found to possess drought-resisting properties of a high order. For silage purposes a combination of Ladino clover (a giant species of white clover) and

Aberystwyth "mop" cocksfoot has given exceptionally good results.

An interesting development in the pasture work at Cornell is the detailed examination of the movements of grazing animals, during which the actions of beef cows are accurately recorded throughout complete periods of 24 hours. It had been found that a cow grazes only 8 hours daily, lies down 12 hours, 'stands about' 4 hours, and chews the cud 7 hours. It walks about 2½ miles a day, drinks water only once, and grazes to within half an inch of the ground surface. It prefers herbage that is four to five inches long, and if the grass grows longer than this its consumption falls off. Altogether, this piece of research provides a remarkable confirmation of the value of rotational grazing.

The second paper dealt with the organization of agricultural education in the United States, and was given by Prof. R. Rae, of the University of Reading, who recently made a tour of the principal agricultural colleges in America. In general, the American system resembles that in Britain, for the activities of each centre fall into three main sections, teaching, experiment or research, and extension service. Prof. Rae, however, was very favourably impressed with the way in which all the various agricultural services, both State and Federal, are grouped together in the same town, and he believes that Great Britain might well give serious consideration to this point when considering post-war organization. Equipment for teaching purposes is on a much larger and more generous scale than we have ever aspired to; some of the examples quoted by Prof. Rae left no doubt in the minds of his audience on this point.

Extension work was described as "the educational arm of agriculture in the United States. It is a co-operative project between Federal, State and local governments, and private groups of farmers and people. . . . It has a large number of local unpaid volunteer leaders consisting of farmers and farmers' wives, and a relatively small paid staff". These extension services combine in America the fields of work covered in Great Britain by the advisory service and the county agricultural staff. From Prof. Rae's paper, however, one got the impression that it goes further than the British system; for example, there are more than a million volunteer neighbourhood extension leaders organized into a system whereby the Government can reach every farm family with important information on measures necessary in connexion with the War, while "through doing, and leading others, the rural man, woman or youth who takes part in extension work experiences a change in his or her person. This change is one that builds ability and greater confidence in self and future".

PEOPLES OF NEW GUINEA

THE ninth of the Smithsonian War Background Studies series deals with New Guinea*, that fascinating island which lies to the north of Australia and has been so much in the public eye since Japan entered the War. With its central backbone of high mountains and its coastal areas of swamp or coral reef, it is an island of great contrasts, while the discovery of gold in the interior proved a notable addition to the valuable traffic in bird of paradise plumes—now forbidden. The island is divided into three portions, the westerly administered by the Netherlands, the south-east by Australia and the north-east, formerly German, also by Australia under a mandate. Owing to the difficulty of travel, which was done for the most part by rivers, the interior remained only partially explored until recently when air transport to the goldfields opened up a great deal of the interior.

The natives are of three main stocks, the Negritos in the northern mountains, the Papuans and the immigrants from Melanesia; there has, naturally, been a lot of inter-marrying, but the three groups are easily distinguishable. The Negritos are a small woolly-haired people found at certain spots along the central range, living still in the stone age, and with bows and arrows and a deadly stone axe as weapons. They are on the whole a friendly and cheerful people and presumably the earliest human inhabitants. The Papuans, who also arrived in the island at an early date, are the characteristic racial stock and are a bigger race than the Negritos; they are dark-skinned, woolly-haired and inclined to be bearded. They occupy most of the interior of the island and all the west and south-western coastal region from Geelvink bay to the Gulf of Papua, as well as other scattered areas. Although they practise a certain amount of simple cultivation, they are more typically hunting and fishing folk with a strong tendency towards cannibalism, headhunting and fighting in general. The Melanesians—the latest arrivals—are found around the east, north-east and south-east coasts and are a lighter-skinned race with hair that may be frizzy or wavy. (The author's statement that they are dark-skinned and woolly-haired does not tally with the descriptions by Seligman and other authorities.) They are a sea-going folk with fine outrigger or double canoes and are of a more cheerful disposition than the often morose Papuans.

It is a pity that some photographs of these attractive people and their culture in the south-east could not have been included in this publication, instead of the illustrations being confined to Netherlands New Guinea.

K. RISHBETH.

* Smithsonian Institution. War Background Studies, No. 9: The Native Peoples of New Guinea. By M. W. Stirling. (Publication 3726.) Pp. vi+25+28 plates. (Washington, D.C.: Smithsonian Institution, 1943.)

EDUCATION IN THE ARMY

DURING the winter of 1942-43 Dr. S. J. Curtis acted as chief instructor at the various courses of army education held at the University of Leeds. The courses were designed to be of assistance to regimental instructors who, on returning to their units, were invited to lecture and introduce discussions and in other ways promote the growth of the war-time scheme for education in the Army. As the courses proceeded it was recognized that a useful purpose would be attained by providing the instructors with information about the institution to which they owed allegiance, the British Army. Most soldiers have some knowledge of their particular regiment, but many are unfamiliar with the regiment's place in the general background of the Army. Dr. Curtis' excellent little volume[1] has been prepared to meet the deficiency. The soldiers who read it will scarcely avoid feeling a legitimate pride as members of an organization whose proud record is still unfolding. "The Story of the British Army" should find its way to every unit library and would still reward the

soldier who added it to his already over-weighted haversack.

"Adult Education in H.M. Forces"[2] suggests that the book is mainly concerned with a description of the educational scheme which has been developed in all three Services. This is not so. It has been designed particularly for the use of regimental instructors. On the other hand, Major Phillips and Capt. Curtis are much too modest in stating that the book would be useful only for unit *education* instructors. It would be of considerable value to all men and women in H.M. Forces whose duty it is to train other men and women in the use of weapons, the principles of wireless, the precautions to take against gas attacks or any other duty which involves the use of the instructional method. This point is admirably summed up in the preface by Brigadier C. G. Maude, Controller of the Army Educational Corps, in his remark that "it is now no longer enough for an instructor to 'know his stuff', he must be able to 'put it across' in a clear and interesting manner".

The introductory chapter contains a brief account of the development of education in the Army. For the instructor the well-written chapter on "How People Learn" should be of great value. Here the authors emphasize the point that the real aim of the instructor is to stimulate others to learn, and not merely to impart knowledge. This brings out the important point that instruction is an active process for both speaker and listener.

Other sections of the book deal with the manner in which a talk might be prepared, the use of visual aids and the methods of guiding discussions. One or two examples to illustrate teaching method are included as well as some useful hints on how to handle adult classes. The book will be warmly welcomed by many Service men and women who, for the first time, have been called upon to instruct others.

[1] "The Story of the British Army". By Dr. S. J. Curtis. Pp. 48. (Leeds: E. J. Arnold and Son, Ltd., 1943.) 1s. 6d. net.

[2] "Adult Education in H.M. Forces". By Major J. O. R. Phillips and Dr. S. J. Curtis. Pp. 68. (Leeds: E. J. Arnold & Son, Ltd., 1943.) 2s. net.

TESTING AND RATING AIR FILTERS

EQUIPMENT for securing data on the efficiencies of air filters is described in an article by O. C. Eliason (*Bell Lab. Rec.*, 21, No. 8; April, 1943). The laboratory test for measuring the capability of a filter consists in passing air containing a known concentration of a standard dust through the filter and measuring the amount of dust remaining in the air. The equipment includes a wind tunnel with a variable speed blower for controlling the volume of air, and there are pitot tubes and gauges for measuring the flow and the static pressure of the air in the tunnel.

A machine has been developed for feeding dust into the air stream in the tunnel at a constant rate. A chain carries the dust from a hopper and drops it into an aspirator tube, from which it is blown into the air stream of the wind tunnel. A moving arm in the hopper stirs the dust and also wipes across the chain to ensure that it carries a uniform load. A standard dust, consisting of a mixture of lamp-black, powdered charcoal, iron oxide and wood flour, was chosen after considerable experimentation. It contains those components of natural dust which are most likely to tax the ability of air filters where dust conditions are severe.

An air sampling instrument for use in the field or in the laboratory was developed as a relatively accurate and easy means of determining, by weight, the amount of dust in the atmosphere and at the same time, by a discoloration test, affording a visual indication of the amount and character of the dust. It consists of a cylindrical chamber with one end screened and provided with a pipe, equipped with a pitot tube for measuring air flow, which connects the chamber with the suction side of a blower. To obtain a sample of the dust in the air, a white filter paper is placed over the screen and air is drawn through it at a constant rate. The dust in the air is deposited on the paper and its amount is quantitatively the difference in the weight of the paper before and after the test. The visual indication is given by the discoloration of the white filter paper.

The air filter on test is installed in the end of the wind tunnel and the volume of air through it is adjusted to its rated value. The dust feeder is then started, the volume of air and the rate of dust feed being constant throughout the test. Samples for determining efficiency are taken during the first hour and at specified intervals thereafter. Efficiency of dust removal is expressed as a ratio of the dust removed compared with the dust in the air entering the filter.

From the weight of dust fed during the test and the volume of air delivered by the blower, the amount of dust in grams per cubic foot of air entering the filter can be calculated. The corresponding amount of dust in the air leaving the filter can be calculated from the weight of that collected on the filter paper and from the volume of air passed through the filter paper. The filter paper is weighed before and after test on a balance sensitive to a tenth of a milligram, in a room in which temperature and relative humidity are constant. When tests are to be made outside the laboratory on air filters installed in a ventilating system two samplers are used, one on the intake side of the filter and the other on the outlet side. The efficiency of the filter is calculated from the difference in the weight of dust collected on the two filter papers.

A NEW ORDER OF CRUSTACEA*

THE minute crustacean which is the subject of this paper is a very interesting discovery. *Derocheilocaris typicus* n.g., n.sp., was found on the intertidal beaches and is regarded by the authors, probably justifiably, as belonging to a new order, which they name Mystacocarida. Although obviously closely allied to the Copepoda, it differs fundamentally in certain respects and is highly specialized in some ways and very primitive in others. The body consists, as in the Copepoda, of sixteen somites, of which the last six are legless. The somite of the maxillipede (first thoracic somite) is completely separated from the head—a most unusual feature. The last six

* Mystacocarida. A New Order of Crustacea from Intertidal Beaches in Massachusetts and Connecticut, by Robert W. Pennak and Donald J. Zinn. (Smithsonian Miscellaneous Collection. Vol. 103. No. 9. Smithsonian Institution, Washington, Publication 3704. 1943.)

somites are regarded as abdomen, but a comparison with Gurney's[1] diagram (p. 33, Figs. 22–23) of the segmentation of a copepod shows a more likely interpretation to be that the first three are thoracic, the corresponding legs being lost altogether. Thus the body would be divided into a head of five somites, thorax of eight, and abdomen of three. The four legs present are simple and leaf-like.

The mouth parts are relatively unspecialized and apparently function in straining food particles out of interstitial water of sandy beaches. There is a large labrum. On the antenna of the larval stages is a so-called "quasi-palp" which disappears in the adult. It is suggested by the authors that this may function (or at one time did function) as a clasping organ, and in that case that the fifth larval stage may be (or may have been) a functional male phase. It seems clear, however, that this "quasi-palp" is homologous with the masticatory process of the Branchiopod larva (see Gurney[2], p. 18, Fig. 5). Five larval stages were found, but not a complete series, and there are probably still younger forms. All have two pairs of antennæ, mandibles, labrum, second maxillæ and caudal rami, only the two last having the first maxillæ and maxillipedes, although all have the so-called postcephalosome (somite of the maxillipede) already formed. No males were seen.

A very strange feature is the presence of the genital opening on the first thoracic somite. If correct, this is a fundamental peculiarity. More evidence is required, especially the tracing of the gonoduct.

It is claimed that in Derocheilocaris we have the most primitive living crustacean yet discovered. In spite of its undoubtedly primitive features, however, and its unique peculiarities, its close relationship with the Copepoda and even further specialization, particularly shown in the greater reduction of the thoracic limbs, make this supposition untenable. It is hoped that further details of this most interesting animal will soon be available.

[1] Gurney, R., "British Freshwater Copepoda", vol. 1. Ray Society (1931).

[2] Gurney, R., "Larvæ of Decapod Crustacea". Ray Society (1942).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned :

ASSISTANT HORTICULTURAL OFFICERS (2)—The Executive Officer, Essex Institute of Agriculture, Writtle, Chelmsford (August 14).

LECTURER IN PHYSICS (TEMPORARY)—The Acting Secretary of University Court, The University, Glasgow (August 15).

LECTURER IN PHYSICS—The Principal, College of Technology and Commerce, Leicester (August 16).

PRINCIPAL OF THE QUEEN'S ROYAL COLLEGE (Secondary School for Boys), Trinidad—The Secretary (I.P.R./C.A.), Board of Education, Belgrave Square, London, S.W.1 ; residents in Scotland should apply to The Secretary, Scottish Education Department (Branch Office), 29 St. Andrew Square, Edinburgh (August 16).

ASSISTANT LECTURER AND DEMONSTRATOR IN THE PHYSIOLOGY DEPARTMENT—The Secretary, The University, Birmingham (August 18).

LECTURER IN CHEMISTRY in the Brighton Technical College—The Education Officer, 54 Old Steine, Brighton 1 (August 18).

LABORATORY STEWARD IN THE SCIENCE DEPARTMENT of the Doncaster Grammar School—The Chief Education Officer, Education Offices, Doncaster (August 21).

HEAD OF THE DEPARTMENT OF INDUSTRIAL ADMINISTRATION—The Registrar, College of Technology, Manchester 1 (August 23).

PROFESSOR OF ANIMAL HUSBANDRY (HYGIENE AND DIETETICS)—The Secretary, Royal (Dick) Veterinary College, Edinburgh (August 31).

POWER STATION SUPERINTENDENT—The Engineer and Manager, Brighton Electricity Undertaking, Electric House, Castle Square, Brighton 1 (endorsed 'Power Station Superintendent') (August 31).

DEPUTY DIRECTOR OF THE RESEARCH DEPARTMENT AT [illegible] BOROUGH—The Secretary, Institution of Production Engineers, Portman Square, London, W.1 (endorsed 'Deputy Director Research').

SUPERVISOR in connexion with the NATIONAL MILK [illegible] SCHEME, and a DAIRY BACTERIOLOGICAL ASSISTANT, in the Univers[illegible] of Bristol—The Chief Advisory Officer, Agricultural Advisory Offic[illegible] 22 Berkeley Square, Bristol 8.

ASSISTANT MASTER TO TEACH SCIENCE (with an ENGINEERING [illegible] and PRACTICAL MATHEMATICS in the Forest of Dean Mining [illegible] Technical School and East Dean Grammar School—The Secretar[illegible] County Education Office, Shire Hall, Gloucester.

LECTURER IN EDUCATION, PSYCHOLOGY, AND SOCIAL PHILOSOPHY—The Clerk to the Governors, South-West Essex Technical College [illegible] School of Art, Forest Road, Walthamstow, London, E.17.

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